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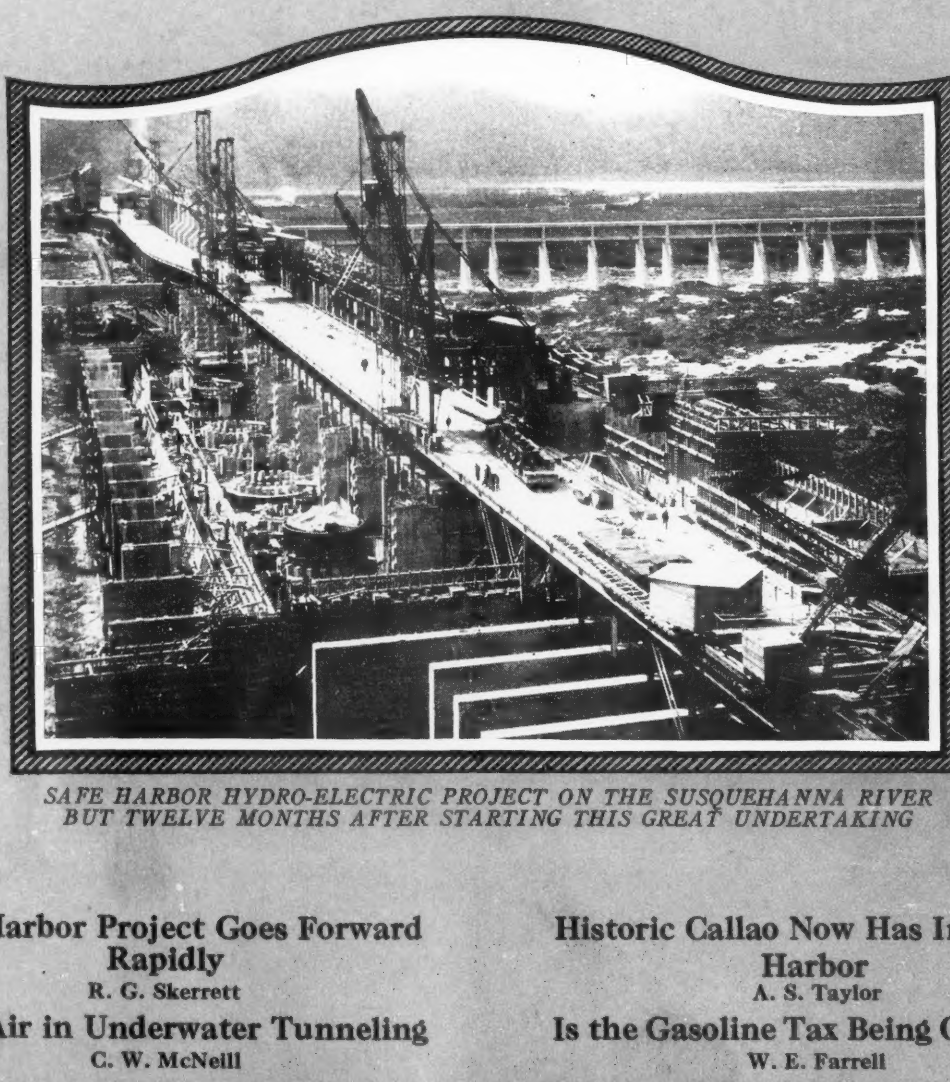

*SAFE HARBOR HYDRO-ELECTRIC PROJECT ON THE SUSQUEHANNA RIVER BUT TWELVE MONTHS AFTER STARTING THIS GREAT UNDERTAKING*



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# Another new—
# "Multi-Vane" Grinder

The 4F fitted with Elastic Bonded Grinding Wheel (Part 37) and Wheel Guard (Part A6)

# The 4F

## Surface Grinder and Sander

A lightweight, high-production tool for grinding, sanding, polishing, and wire brushing. A powerful, smooth running, and correctly balanced machine from which you can expect maximum production and high efficiency.

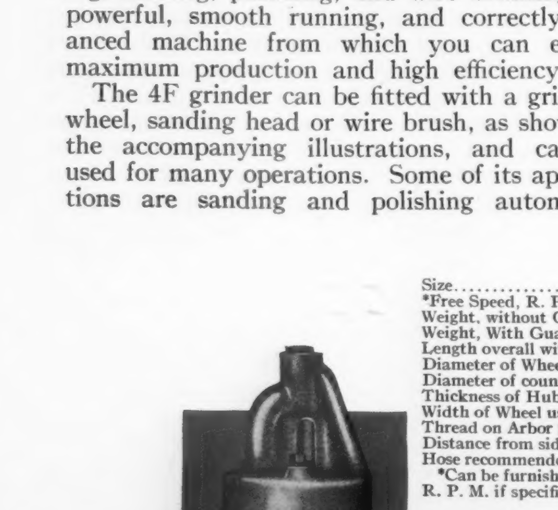
The 4F grinder can be fitted with a grinding wheel, sanding head or wire brush, as shown in the accompanying illustrations, and can be used for many operations. Some of its applications are sanding and polishing automobile bodies, smoothing down welds, cleaning and surfacing large castings for painting, polishing locomotive side rods, sanding metal furniture and dies, and cleaning pipe and other material.

The machine has two handles on the side, so that the operator can readily hold it at right angles to the work. One of the handles is "dead". It can be removed when working in close quarters. The other is a live air handle containing a thumb-controlled throttle valve.

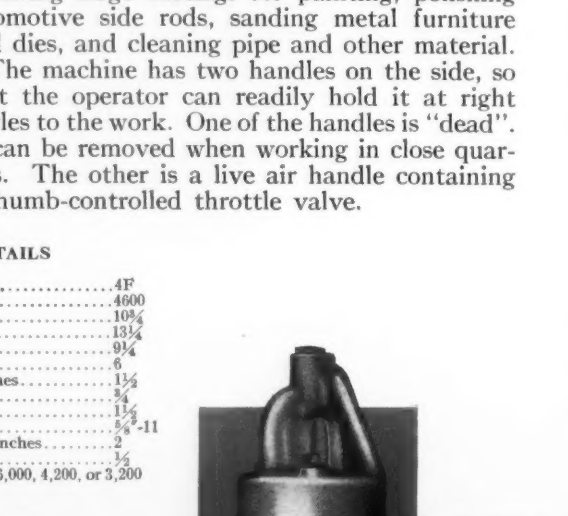
**PRINCIPAL DETAILS**

| | |
|---|---|
| Size | 4F |
| *Free Speed, R. P. M. | 4600 |
| Weight, without Guard, lbs. | 10¾ |
| Weight, With Guard, lbs. | 13¼ |
| Length overall without wheel, inches | 9¼ |
| Diameter of Wheel used, inches | 6 |
| Diameter of counterbore in Wheel, inches | 1½ |
| Thickness of Hub in wheel, inches | ¾ |
| Width of Wheel used, inches | 1½ |
| Thread on Arbor for Wheels | ⅝"-11 |
| Distance from side to center of arbor, inches | 2 |
| Hose recommended, inches | ½ |

*Can be furnished with free speed of 6,000, 4,200, or 3,200 R. P. M. if specified.



The 4F fitted with I-R Sanding Head (Part No. A225)



The 4F fitted with I-R Cup-Type Wire Brush (Part No. 28). Coarse or fine brushes can be furnished.

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# As It Seems To Us

### STAVING OFF COMMON COLDS

WE have been surfeited with figures intended to disclose how much the people of the country pay directly or indirectly each year because of disabilities due to so-called common colds. Medical scientists are busy seeking with test tubes and microscopes the bugs responsible for these maladies, but none of the results to date can be called all-conclusive. Even so, there are recognized ways of guarding oneself against infection; and the mechanics of the problem were lucidly presented recently by Dr. LLOYD ARNOLD in *The United States Daily.*

According to this bacteriologist, most of us can make ourselves far less susceptible to colds by paying more attention to the foods we eat and by accustoming our bodies to changes of temperature—warm baths and cold showers helping in this direction. Within well-defined limits, our defense against catching cold is affected by the activity or the sluggishness of the tiny blood vessels just beneath the surface of the skin; and the performance of these capillaries is largely due to our diet. Therefore, to induce a healthy reaction upon exposure to either heat or cold one should adopt a balanced diet and avoid too much fuel like sugar and starch which "smoke up" the physical machinery. A balanced diet is one consisting of meat, cereals, cooked and fresh vegetables, and fruit in due proportions.

Doctor ARNOLD says: "If one wants to have a head cold one should eat the following: Cereal and coffee for breakfast; a piece of chocolate cake or pie for lunch; and a beefsteak with potatoes for dinner." Furthermore, he points out that muscular exercise brings about an advantageous redistribution of the blood in the circulatory system, and the body profits proportionately. Walking and other exercise in the open air increases our defense by stimulating the skin through contact with the cooler outdoor air; and hot baths, succeeded by cold showers, also speed up the reactions of the blood vessels lying immediately beneath the skin. These capillaries are to the body what leaves are to a tree.

Finally, this official of the Department of Public Health of the State of Illinois sums up in the following words what it is best for us to do: "The prevention of head colds can best be accomplished by a person adapting himself to the world in which he lives. This is an individual responsibility. A person is not immune to colds after one or more attacks. If he cannot build up his own immunity, antiserum and vaccines certainly cannot do it for him. He should harden his body by sound eating and healthy habits, and avoid the person with a bad cold."

Remember the insidious pie, the seductive steak, and too much of the starchy spud when made more delectable by frying!

### MORE POWER FROM THE SUSQUEHANNA

SAFE Harbor, Pennsylvania, is an unpretentious community that is lending its name to a magnificent hydro-electric undertaking that will impound the Susquehanna River for a distance of ten miles upstream and utilize the waters so arrested to turn eventually twelve great turbines capable of developing a total of half a million horsepower. This project is the third of its kind built on the lowermost stretch of the stream which drains a watershed having an area of 27,400 square miles.

Despite the fact that the Susquehanna pours more water into the North Atlantic Ocean than any other river save the St. Lawrence, still the river throughout the stretch mentioned has not been used for transportation for a goodly number of decades. Therefore, the utilization of the stream for the generating of electric energy is in the direction of modern progress, and especially so inasmuch as the current can be transmitted economically over far-flung zones to serve millions of people in providing needed light and power.

A particularly interesting aspect of this project is that it is located on the river at a point where William Penn planned two centuries and a half ago to establish a large city. Furthermore, the immediate region is rich in relics and records of Indian occupations covering successive periods of many hundreds of years. Evidences of these remote times are being garnered before the impounded waters submerge them to considerable depths. In these efforts of potentially great historic significance both the authorities of the State of Pennsylvania and the officials of the water-power company are collaborating wholeheartedly—the public utility, in fact, subscribing generously to the funds needed for the explorations in hand.

Work on the Safe Harbor undertaking was started in the river so recently as April of 1930; and the engineering concern on the job has made splendid progress, thanks to the skillful employment of modern machinery. Unless the unexpected happen, there is every reason to believe that the six generators to be installed at the beginning will be ready to send current into the distributing system early in 1932.

Hydro-electric projects of this nature and size inevitably arouse wonderment, because the layman finds it hard to grasp offhand how it is possible to divert the flow of a large river and to unwater its bed so that the dam and the power house may be securely bonded with the underlying supporting rock. This must be done in a way to safeguard against the sweep and the stresses set up during flood periods; and in this respect the Susquehanna is conspicuous, because it is subject to extremely varied volumes of flow.

The Safe Harbor hydro-electric project when finished will represent an outlay totaling approximately $30,000,000.

### ONE MORE CRISIS

NO less an authority than Mr. H. M. HOAR, of the Minerals Division of the Bureau of Foreign and Domestic Commerce, declares that the world at large is surfeited with marketable coal and, therefore, that that fuel is face to face with an economic crisis. This situation is disquieting to the industry that has been delving in the depth of the earth for generations in order to provide our factories, our railroads, and our people generally with the means of producing heat for power and other purposes.

It seems that the three principal coal-exporting countries of Europe have for some years been operating at surplus capacities ranging roughly from 25 to 50 per cent. This state of affairs was brought about by wartime conditions that compelled many nations to become largely self-dependent where formerly they had purchased a measurable percentage of the commodities denied them or the supply of which was curtailed during the years of conflict. As a consequence, people cast about them for other sources of heat and energy. Hydro-electric developments, the utilization of lignite, peat, powdered coal, natural gas, and fuel oil have all had their effects upon the character and the quantities of coals that could be marketed.

It seems that while the production of raw materials and foodstuffs and the trade of the world in 1928 surpassed that of 1913 by more than 20 per cent, still the world consumption of coal was only 4 per cent greater in 1928 than it was in 1913. This is highly significant, because in the past the demand for coal has commonly grown in keeping with the demand for other raw materials. While one might be prompted to ask: "How will this trend affect the coal industry in the years to come?", still there is no excuse for jumping to a gloomy conclusion. Let us bear in mind that other basic industries are in something of a similar fix. It is reasonable to suppose that research and the inevitable return to normal will restore coal to its accustomed economic status; and when that day comes, coal may enjoy even a better position than it has in the past.


**One of the four big gantry cranes serving to handle materials and to place concrete in building Safe Harbor Dam.**

**Typical appearance of unwatered river bed. Camera pointed downstream toward skimmer wall.**

# Work on the Safe Harbor Hydro-Electric Project Goes Forward Rapidly

*This Third Big Power Plant on the Lower Stretch of the Susquehanna River Is Designed Ultimately to Develop 510,000 Horsepower*

By R. G. SKERRETT

WHERE William Penn planned about 250 years ago to create a large city on the banks of the Susquehanna River, the Safe Harbor Water Power Corporation is now hastening towards completion a great hydro-electric undertaking the turbines of which will ultimately develop a total of 510,000 hp.

Passing time has thus wrought a change of purpose; and present-day demands and modern mechanical facilities are making possible a vast enterprise that never dawned upon William Penn's fertile mind when he imagined a populous municipality at that point where Conestoga Creek empties into the Susquehanna. The name Safe Harbor recalls that period in the history of Pennsylvania when the Susquehanna served as a vitally important trade route; and before describing what the water-power corporation is now doing we shall dwell briefly upon the part played by this big river in developing the industrial life of the Keystone State.

Back in 1771, the Provincial Assembly declared the Susquehanna a public highway; and some money was then appropriated to render the stream navigable. The pioneer families journeyed up river in what were known as Durham boats—flat-bottomed craft, 60 feet long, 8 feet wide, and 2 feet deep, that drew 20 inches of water when carrying a burden of 15 tons. A little later the farmers of Columbia County, using various types of river craft, transported their wheat and flour to a ready market in Baltimore. Years subsequently, great rafts of logs, cut from the densely timbered Pennsylvania hills far upstream, were floated down each spring to the vicinity of Washington Borough. This practice was continued until about 1840. High water in the springtime made it possible, although hazardous, for the raftsmen to negotiate the rock-strewn rapids that lay in the course of the river for some distance below Washington Borough; and the passage of those turbulent waters exacted annually a toll of life and limb.

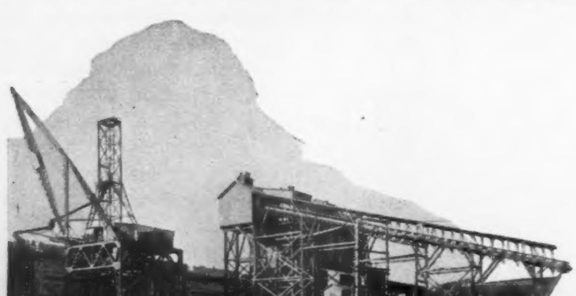
Just below that dangerous area the river resumed a relatively untroubled course, and there it was the exhausted drivers paused for rest. Because of this available security, so it is said, the neighboring community—originally known as Millport—acquired the name of Safe Harbor. Be this as it may, Safe Harbor proved true to its name for the better part of a century and until it narrowly escaped destruction early in 1904. The winter had been a severe one, and ice cloaked the Susquehanna from shore to shore. Then in March of that fateful year there was a rapid thaw and the ice started seaward only to be halted at the rapids where a jam formed. When that broke, both the ice and the arrested water swept with irresistible force downstream. Safe Harbor was inundated, the people were driven from their homes, and only by a miracle was the town not entirely obliterated. That happening is of more than historical interest, because it indicates a potentiality against which the Safe Harbor Water Power Corporation has to provide in rearing the dam that will turn the river for ten miles upstream into a vast pool that will be utilized in producing an enormous block of electric current.

Nature has met the hydro-electric engineer halfway in offering physical conditions that lend themselves to the building of a dam of the character and the magnitude now in hand at Safe Harbor. The rocky bottom of the river, although scored and even grotesquely modeled by the erosive action of thousands of years of flowing water, periodic ice, and abrasive sand and gravel, is of a sufficiently stable character to serve as a firm foundation for the footings of the impounding structure and the associate power house. Furthermore, the bluff shores at each end of the dam are admirably suited to be used as anchorages for the terminal bulkhead sections.

Top—Looking downstream upon the scene of operations and showing construction stage in August of last year.

Bottom—Close-up of a section of the west spillway and the Else Island bulkhead as they appeared last November.

The drainage basin of the Susquehanna River has a combined area of 27,400 square miles; and 55 per cent of the run-off of that expansive watershed reaches the sea in the course of a twelvemonth! Indeed, next to the St. Lawrence, the Susquehanna pours more water into the North Atlantic than any other river on the continent. Between Columbia, ten miles above Safe Harbor, and Port Deposit, about 38 miles below, the stream descends 225 feet; and because of this drop the flow has been swift until checked by dams built in the last few years. The first of these was reared at McCall Ferry—now known as the Holtwood Station, which began turning out power in October of 1910. The second dam and power house were constructed at Conowingo and were ready to generate electric energy early in 1928. The plant at Conowingo is close to tidewater; and it backs up the river to the tailrace of the Holtwood Station approximately fourteen miles above. The pool formed by the dam at Holtwood reaches to what will be the tailrace of the Safe Harbor development—the three power houses thus making full use of the drop in the river between Columbia and tidewater. When operating at their designed ultimate capacities, the three stations will have a combined rated output of 842,000 kw.—not counting the unfinished steam plant at Holtwood which is designed to generate 25,000 hp. It should be mentioned here that the lower stretch of the Susquehanna has not been used for transportation for many years.



Central concrete-mixing plant, on Else Island, capable of turning out 2,000 cubic yards in a 10-hour shift.

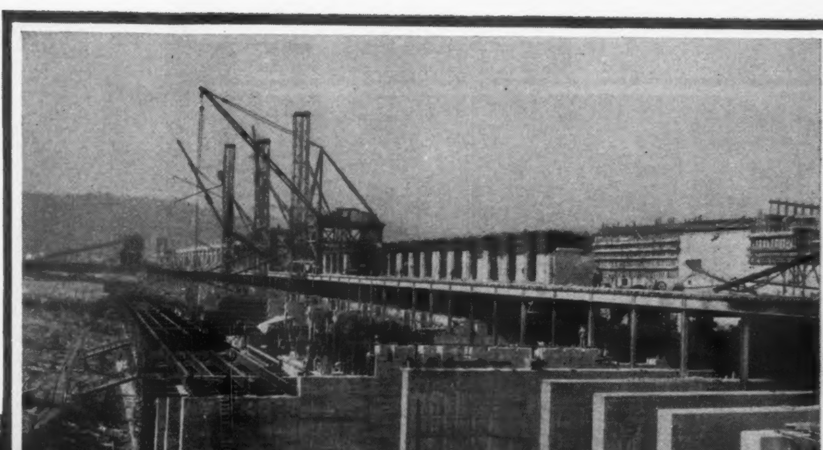
The flow of the river varies widely. The average volume of water is 39,000 cubic feet per second, but under flood conditions this has attained to the magnitude of 725,000 cubic feet per second. The Safe Harbor hydro-electric project will obtain its motive force from the run-off of a watershed covering 26,090 square miles, lying partly in the State of New York but mainly within Pennsylvania. The pond created by the arresting dam will have an area of 10.4 square miles. From shore to shore, this dam and the associate power house will have a total length of 4,984 feet. Ultimately, the plant will contain twelve generating units, and at that time it will have a length of 920 feet and a width of 182 feet. At the start, the station will hold six main water wheels and generators.

Each one of the large main dynamos will be driven by a turbine 18 feet 4 inches in diameter; and the turbines are to be equipped with adjustable blades automatically controlled by a governor on each unit. These water wheels, which are of the Kaplan type, are the largest of their kind in the United States. When working at the designed rate each turbine will develop 42,500 hp., and the connected generator will have a normal output of 28,000 kw. at 90 per cent power factor—that is, the six units will produce an aggregate of 168,000 kw. The current generated in the power house will be delivered to two switching stations high on the hill above the east end of the dam; and from those stations the electricity will be carried over transmission lines to be constructed by the Pennsylvania Water & Power Company. Two of the lines will carry current to Baltimore, while other lines will connect with the existing Holtwood-Lancaster system. Current for station service will be furnished by two 1,750-kw. generators.

In its completed form the impounding structure will be made up of the following main divisions: the west bulkhead, 570 feet long; the west spillway, 1,356 feet long; the centrally located island bulkhead, also 1,356 feet long; the east spillway, 454 feet long; the short connecting bulkhead, 58 feet long; the power house, 920 feet long; and the east bulkhead, 300 feet long. The latter bulkhead completes the barrier and ties it to the river bank on the Safe Harbor side of the stream about a quarter of a mile above the mouth of Conestoga Creek. The west spill-

Top—Downstream face of the dam showing advanced state of the work in April just past.

Bottom—Construction of one of the six turbine installations with which the plant will be equipped at the start.



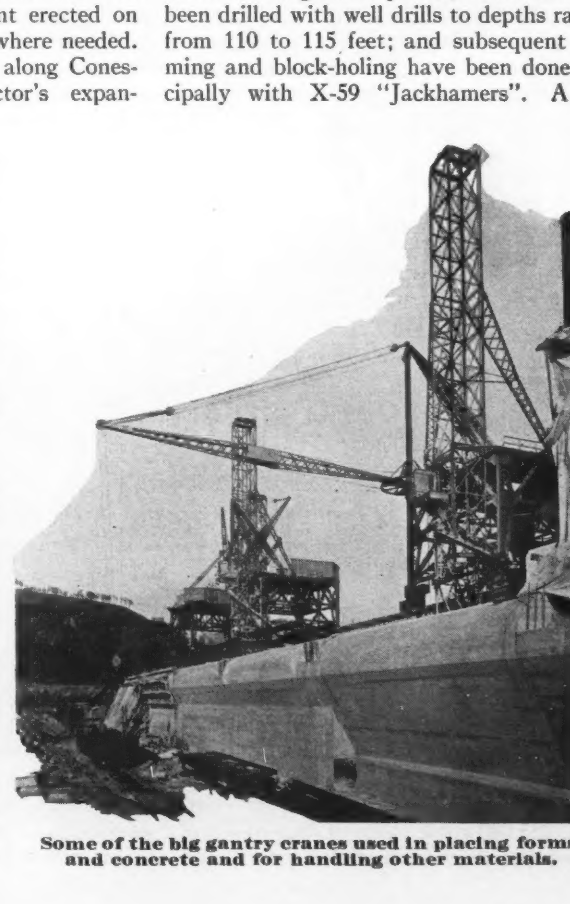
way will be equipped with 24 Stoney type gates each having a clear span of 48 feet; and the east spillway is to be provided with four Stoney gates of similar size as well as with four double-leaf gates to be used for regulating purposes. The spillways are commodious enough to provide outlets for an aggregate of 970,000 cubic feet per second when the pond is at its initial normal elevation. So much for the general characteristics of the dam and the power house. Now for some details of how this great undertaking is being carried forward so that the plant can be put into service early in 1932.

The contract for the construction work was awarded The Arundel Corporation, of Baltimore, Md., in the fall of 1929; and shortly afterwards—in November—the building of a well-equipped, self-contained camp was begun. This camp can take care of 700 men—that is, about one-fifth of the total maximum force likely to be engaged. With certain preliminaries settled, and the river in a favorable state, work on the first cofferdam was started in April of 1930. That cofferdam encloses an area of about 130 acres. The two main arms extend out from the Safe Harbor side of the river and made it possible to unwater the confined area so as to expose the rocky bed of the Susquehanna. The entire flow of the river was thus diverted into a channel at the west or York County side of the stream. Within this unwatered area has been excavated the tailrace; and the forebay skimmer wall, the power house foundation, the eastern spillway, the Else Island bulkhead, and the bulkhead reaching to the eastern shore have been completed as we go to press. The cofferdam, which embraces a section of Else Island, in midstream, was made high enough and strong enough to withstand a river-flood period up to 350,000 cubic feet per second. The lower arm, close to the mouth of Conestoga Creek, has been serving as a viaduct for trains carrying materials out to the big concrete-mixing plant erected on the island and to other points where needed. These tracks extend inland up along Conestoga Creek to the contractor's expansive freight yard and also to the quarry and to the stone-crushing plant situated in a valley leading off from the creek.

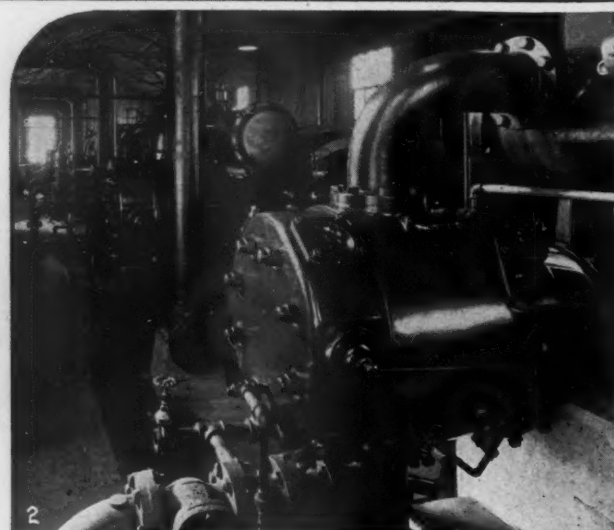
The dam and the power house are paralleled on the downstream side by a temporary steel bridge 42 feet wide. This is so constructed that the steelwork will have a high salvage value. On this bridge are carried four traveling gantries. The four gantries—one with a derrick boom 100 feet in length and three with 80-foot booms—are provided with towers for chuting concrete into place. The bridge is wide enough to provide three tracks of standard gage over which are moved construction materials of all sorts.

The concrete-mixing plant adjacent to the bridge contains four Ransome 2-yard mixers; and it is capable of turning out 2,000 cubic yards during a 10-hour shift. All concrete for the undertaking is mixed in this central plant; and before the job is completed it will probably have to produce a total of 460,000 cubic yards of concrete. The necessary sand has been brought up from Chesapeake Bay; and the trap rock used has been obtained from a quarry opened up by the contractor for that purpose. The trap rock is in the form of an unexpected dike outcropping in the midst of the prevailing schist and limestone of the countryside. The limestone answers admirably for fill and for railroad ballast when crushed; and these uses of the limestone, removed in getting at the trap rock, have lowered the quarry cost of the latter. A borrow pit adjacent to the trap-rock dike has also furnished much rock for fill, etc.

In removing the trap rock, down holes have been drilled with well drills to depths ranging from 110 to 115 feet; and subsequent trimming and block-holing have been done principally with X-59 "Jackhamers". A suit-



**Some of the big gantry cranes used in placing forms and concrete and for handling other materials.**



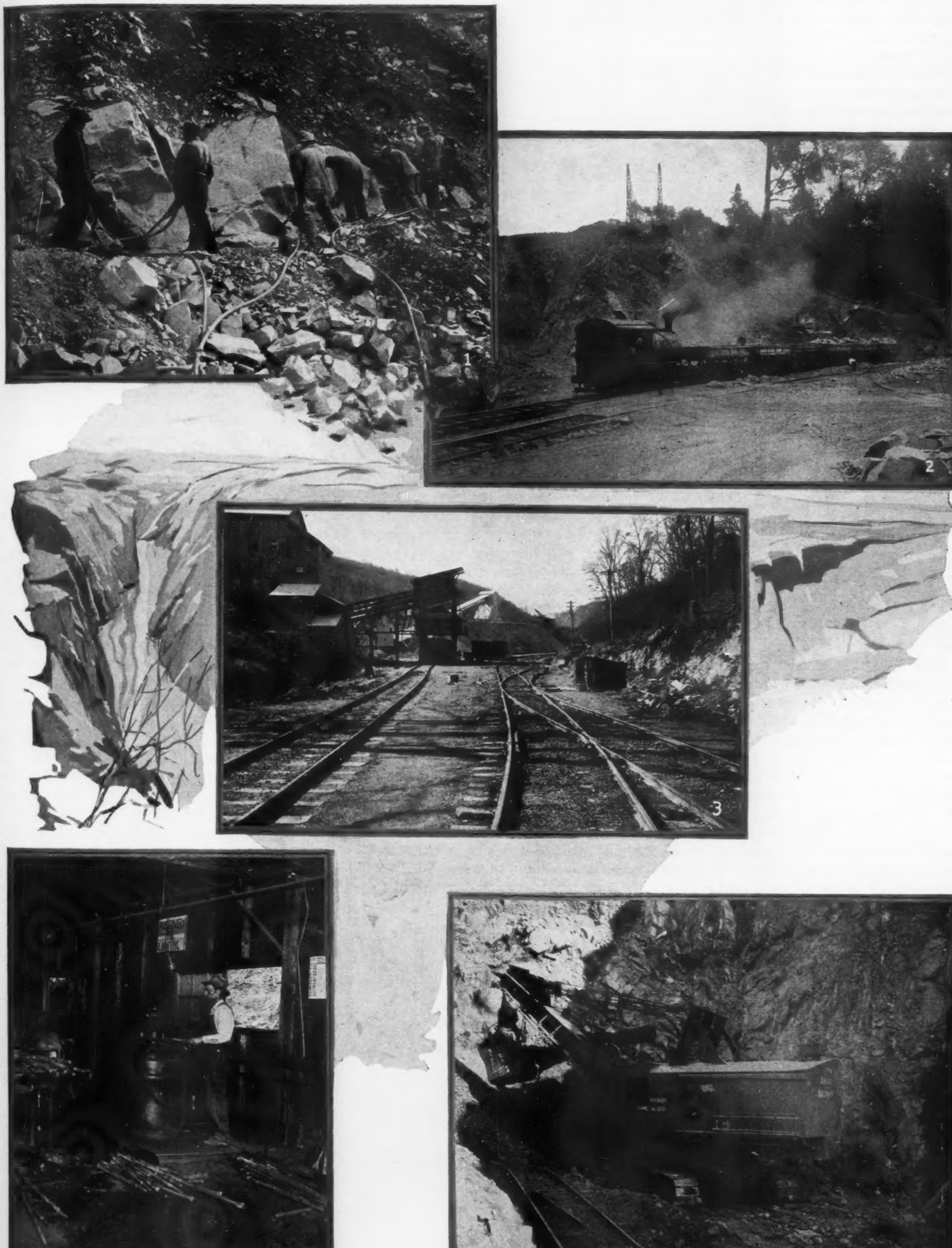
1—Two Type Twenty 10x8-inch portables furnishing air at a point beyond the main air-line system. 2—These six XRE compressors provide most of the operating air required on the Safe Harbor hydro-electric project. 3—The HM-2 aftercoolers and the receivers connected with the main compressor plant. 4—Group of six Type D wagon drills sinking holes 40-odd feet deep.

ably equipped blacksmith shop, close to the quarry, serves to keep the drill steels properly conditioned. The crushing plant, which is not far from the quarry, is capable of turning out 2,000 tons of stone per 10-hour shift. All told, 285,000 cubic yards of trap rock will be drilled and shot down in the quarry, and 160,000 cubic yards of limestone will be used for fill or ballast on the relocated section of the Columbia & Port Deposit Railroad. From the borrow pit have been drawn and placed in embankments 365,000 cubic yards of rock.

In excavating for the dam, the power house, and the tailrace an aggregate of 369,200 cubic yards of rock has been removed, as follows: the dam, 64,700 cubic yards; the power house, 142,000 cubic yards; and the tailrace, 162,500 cubic yards. Most of this rock has been a tough schist; and to reach a suitable depth on this part of the undertaking it has been necessary to drill to 43 feet below the river bed—that is, more than 100 feet below the future surface of the reservoir. The problem was how to do this work rapidly and to drill holes that should be $4\frac{9}{16}$ inches at the start and $2\frac{3}{4}$ inches in diameter when 40 feet down. The uneven nature of the river bed made the use of well drills impracticable. Accordingly, Mr. George H. Angell—then superintendent for the contractor—elected to employ wagon drills mounted on skids to facilitate shifting from point to point. Eleven slab-back, Type D, skid-mounted wagon drills were used on the job. Each outfit was equipped with a 9-H air-operated hoist to raise or to lower the X-71 wet drill carried. The drill steel was $1\frac{1}{2}$ inches in diameter. Steels were changed every 2 to 3 feet; and the longest steels used had a length of 45 feet. Depending upon the nature of the rock and the depth required, the holes were spaced at 6, 7, and 8 feet. Air was delivered to the drills at a pressure of 95 pounds.

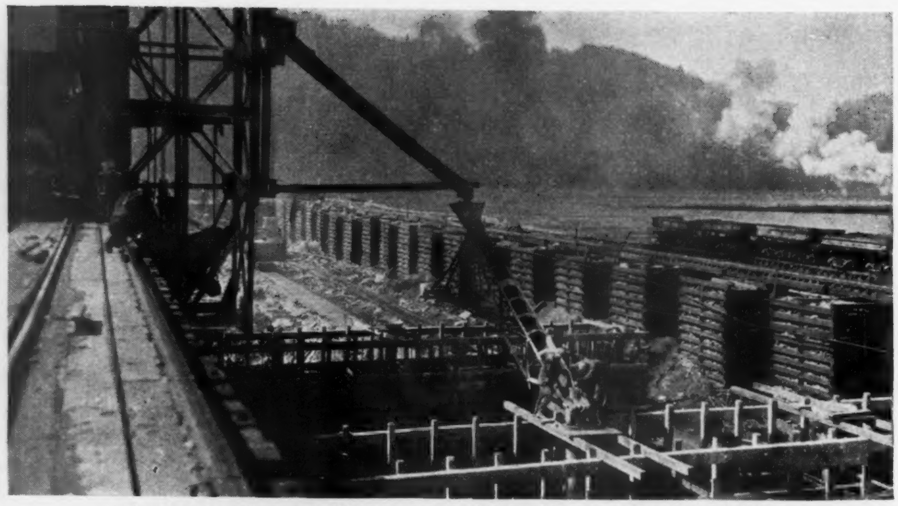
The drill runners worked on a 10-hour shift; and during a shift the footage ranged between 85 and 150 feet. With each change of steel the gage of the bit decreased $\frac{1}{8}$ inch. The explosive used was dynamite of 40 and 60 per cent in $2\frac{1}{4}$-inch sticks. Two blacksmith shops were maintained at strategic points within the cofferdam to condition the steels. These shops, like the blacksmith shop near the quarry, were equipped with No. 26 I-R furnaces, No. 50 sharpeners, and No. 8 pedestal grinders. High-lift sharpeners were installed especially to take care of the large starting bits.

Numerous steam shovels handled the blasted rock within the cofferdam; and various spur lines were run into the unwatered area so that trains could move wherever necessary to load the spoil and to haul it off to points of disposal. Some of this rock has been used to form the breakwater that juts out at right angles from the east bank of the river above the dam. This break-




1—Ingersoll-Rand "Jackhamers" block-holing and trimming trap rock in quarry from which stone is obtained for concrete. 2—Part of the expansive quarry from which 285,000 cubic yards of trap rock will be taken for use in concrete. 3—The crushing plants that prepare all the stone for 460,000 cubic yards of concrete. 4—Blacksmith shop in the quarry. 5—Powerful electrically operated 4-yard Marion shovel at work in quarry.

water connects with the skimmer wall, 1,495 feet long, which terminates at the western end of the power-house section. The breakwater and the skimmer wall enclose the forebay so as to exclude ice and other floating materials from the turbine intakes.



**Main downstream cofferdam seen from the construction bridge.**

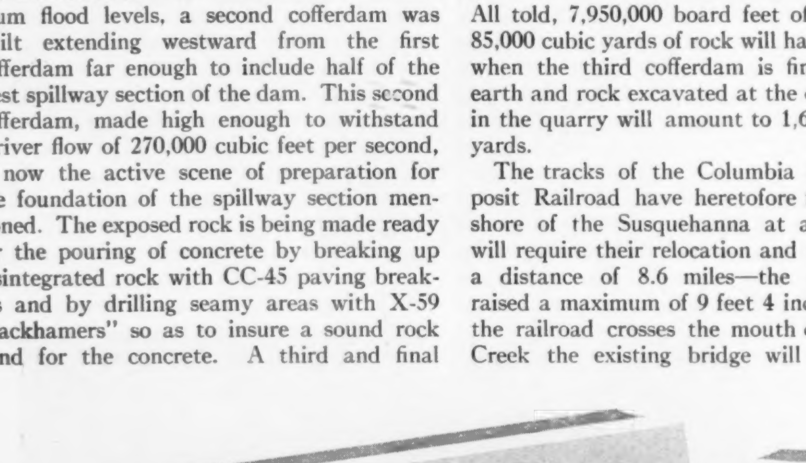
Compressed air has in the main been supplied by a central plant situated on Conestoga Creek. This plant contains six XRE compressors having a total piston displacement of 5,220 cubic feet of air a minute. The compressors deliver their air to two HM-2 aftercoolers, whence it passes into two receivers where a pressure of 105 pounds is maintained. The air is piped from the compressor plant to the quarry, to a machine shop close by, and to the scene of operations out in the river. Beyond the reach of this distributing system, air has been furnished where needed by a battery of 10x8-inch Type Twenty portable compressors. These mobile machines are now being used in railroad relocation work.

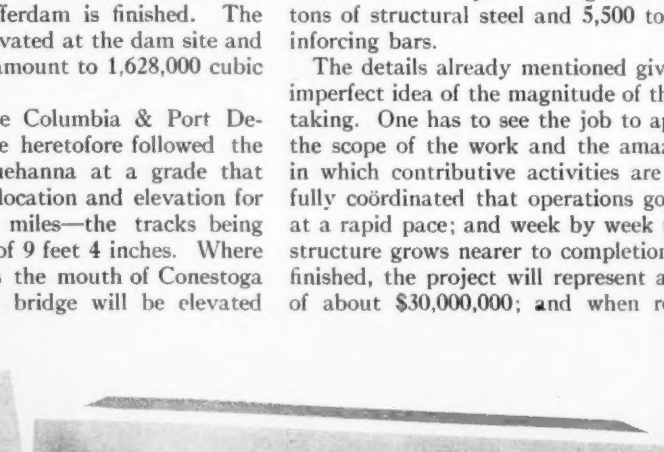
With the completion of the skimmer wall and the dam and power-house headworks in the first cofferdam to elevations above maximum flood levels, a second cofferdam was built extending westward from the first cofferdam far enough to include half of the west spillway section of the dam. This second cofferdam, made high enough to withstand a river flow of 270,000 cubic feet per second, is now the active scene of preparation for the foundation of the spillway section mentioned. The exposed rock is being made ready for the pouring of concrete by breaking up disintegrated rock with CC-45 paving breakers and by drilling seamy areas with X-59 "Jackhamers" so as to insure a sound rock bond for the concrete. A third and final cofferdam will be built during the coming summer, and it will close the gap through which the river is now flowing. When this cofferdam is ready for unwatering, the river will find outlets through the turbine intakes that will eventually deliver water to the six turbines to be installed in the future, and by way of temporary openings in the spillway that will be constructed in the second cofferdam. It may be interesting to point out that all the cofferdams are of the timber-crib type, rock filled, and made tight by wood sheathing on the water side and a blanket of clay to prevent seepage. The cofferdams built to date have been remarkably dry. All told, 7,950,000 board feet of timber and 85,000 cubic yards of rock will have been used when the third cofferdam is finished. The earth and rock excavated at the dam site and in the quarry will amount to 1,628,000 cubic yards.

The tracks of the Columbia & Port Deposit Railroad have heretofore followed the shore of the Susquehanna at a grade that will require their relocation and elevation for a distance of 8.6 miles—the tracks being raised a maximum of 9 feet 4 inches. Where the railroad crosses the mouth of Conestoga Creek the existing bridge will be elevated 4 feet 6 inches. The relocated section of the roadbed will be wide enough for double track. To provide this width at the dam site, the face of the rocky hillside contiguous to the east dam abutment has been cut away for 75 feet. This has been a difficult task because of the steepness of the slope. Holes 40 feet deep, drilled dry, have been driven with X-71's mounted on tripods and wagons, and holes 20 feet and less in depth have been drilled with X-59 "Jackhamers". The nearness of the Atglen & Susquehanna branch of the Pennsylvania Railroad—running at a higher elevation on the cliffside—has added to the contractor's difficulties. By the exercise of much care no blasted rock has interfered with traffic.

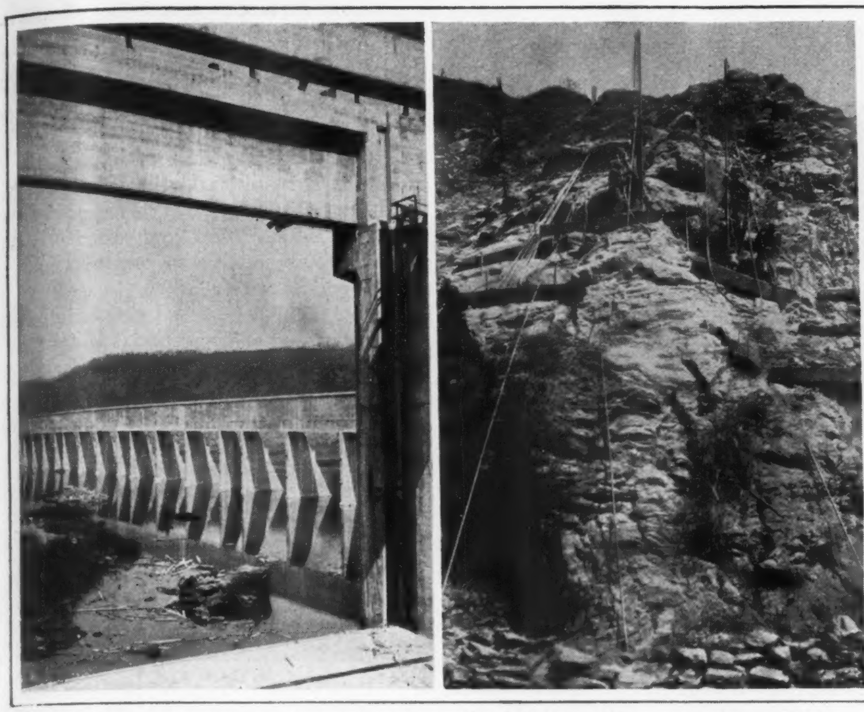
Up to date The Arundel Corporation has had in service on the job a matter of twenty miles of standard-gage railroad track. Twelve saddle-tank steam locomotives, seven gasoline locomotives, 80-odd air-dump cars, and a considerable number of other cars have been employed in hauling materials and spoil hither and thither. The successful completion of an undertaking like the Safe Harbor hydroelectric project resolves itself into a problem of handling on a large scale diversified materials. Into the job is being worked 18,000 tons of structural steel and 5,500 tons of reinforcing bars.

The details already mentioned give but an imperfect idea of the magnitude of the undertaking. One has to see the job to appreciate the scope of the work and the amazing way in which contributive activities are so skillfully coördinated that operations go forward at a rapid pace; and week by week the giant structure grows nearer to completion. When finished, the project will represent an outlay of about $30,000,000; and when ready for





**Left—Side-dump cars conveying concrete from mixer to the placing apparatus. Right—Steam shovels handling broken rock blasted out of dam cut-off.**



Left—Skimmer wall seen through gateway in finished spillway section. Right—Rock drills at work on cliffside clearing way for railroad relocation.

service the plant will turn the flow of the river into a source of electricity that will provide light and power for a multiplicity of purposes within a far-flung zone.

The design of the project has been handled from the start by the engineers of the Safe Harbor Water Power Corporation, and the same experts are supervising the field work. The corporation's engineers will be in charge of the installing of the electrical and mechanical equipment in the power house. All construction work, including installing of equipment embedded in the concrete masses, is being done by The Arundel Corporation. The Safe Harbor hydro-electric plant will be operated by the same organization which, over a period of twenty years, has been in charge at Holtwood.

The following are some of the officials of the Safe Harbor Water Power Corporation: J. E. Aldred, chairman of the board, Charles E. F. Clarke, president; J. A. Walls, vice-president and chief engineer; and H. B. Higgins, assistant chief engineer. Some of the officials of The Arundel Corporation are: Frank A. Furst, chairman of the board; J. J. Hock, president; Joseph V. Hogan, assistant to president and in general charge of all construction; and C. W. Black, chief engineer. Until the first week of the past April, Mr. George H. Angell was superintendent on the job for The Arundel Corporation; and it is with sincere regret that we mention here his sudden death then. Mr. Angell had had a wide experience in the construction of hydro-electric undertakings; and his extensive associations won for him a great many warm admirers who will feel a personal loss in his passing.

Cargo craft designed to ride rapids have been put in operation in the upper reaches of the Magdalena River.

## PERSONALITY OF STEEL A FACTOR

AMONG the many interesting things that metallurgists are continually finding out about steel is the fact that this metal has certain definite inherent qualities which go to make up something akin to what we call personality in human beings. In fact, the resemblance is so close that, for want of a better term, the word personality is being used.

Human bodies are all closely similar in chemical composition, yet races have pronounced characteristics that distinguish them from one another. Within races we find family traits, and within families distinctive individual make-ups. Mental and physical characteristics differ widely among persons. Heredity, environment, and training all play their parts in molding human characteristics.

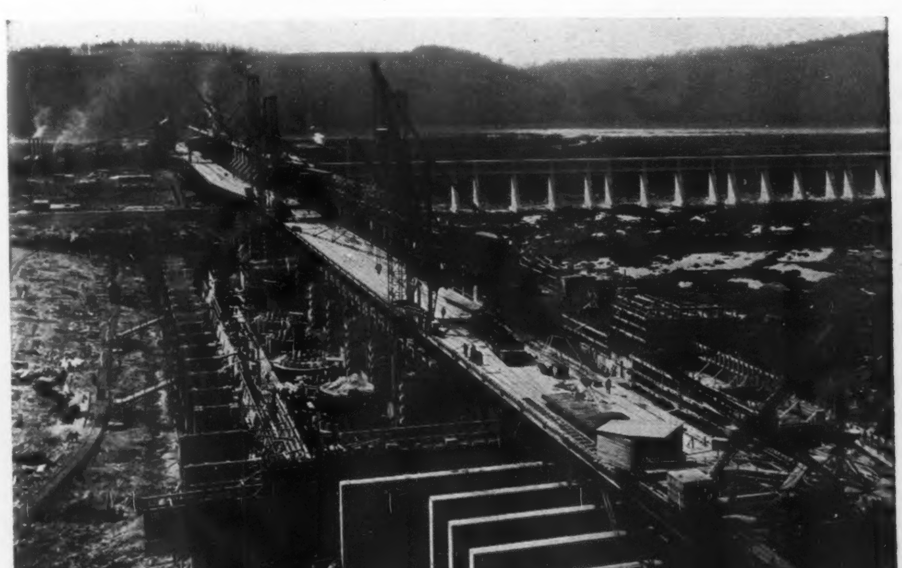
Now it has come to light that two steels of identical chemical composition are not necessarily the same in their characteristics. This is particularly true of tool steels and high-speed steels. Two steels made to the same chemical specifications may show exactly the same reactions to many physical tests and still perform differently in service.

Recognition of these facts is causing a reversion to former principles of buying tool steels and alloy steels. Formerly they were bought by brand name, which designation signified not only the product but the particular quality of that product made by a certain mill. The actual composition of the steel was seldom divulged. Later there came a reaction to these principles. The pendulum swung back the other way, and great emphasis was placed upon the chemical composition of steels.

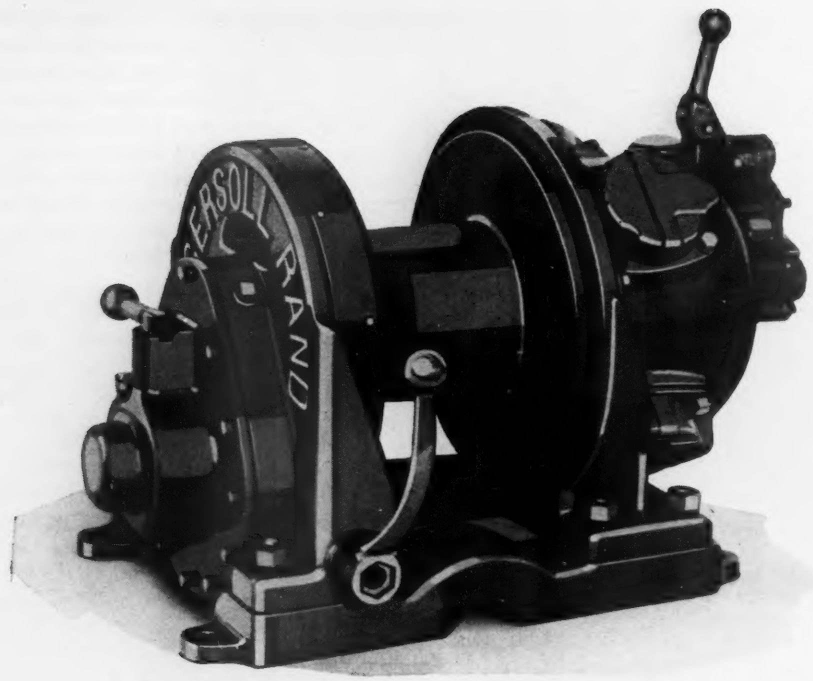
These late developments tend to show that the quality which distinguished a certain brand of steel was in reality determined by the manner in which it was handled in the particular mill from which it came The manner of handling imparted to it those definite characteristics which are now being designated as personality.

All of this has a practical value. In the manufacture of rock drills, for example, it means that, by recognizing and controlling the personality of the steel entering into them, uniform parts which will harden to uniform depths can be obtained. This, in turn, has a marked effect upon the length of service of the drill.

The Ingersoll-Rand Company is one of the concerns that is taking this new character analysis of steel into account. Its metallurgical department, under the direction of Mr. B. F. Shepherd, has, in conjunction with steel-company metallurgists, carried on a great amount of research work on this subject in the interest of a better-performing, more uniform product.



Dam as it appeared in March when photographed from an elevation on the east side of the Susquehanna.




The newest and largest air hoist of the "Utility" class.

## MORE POWERFUL AIR HOIST ADDED TO THE "UTILITY" CLASS

AN addition to its line of "Utility" hoists has been announced by the Ingersoll-Rand Company, 11 Broadway, New York City. The air hoist is designated the HU and is the largest and the most powerful of that particular class. It has a rated capacity of 2,000 pounds at a rope speed of 120 feet per minute; but it can handle 25 per cent heavier loads with safety.

The HU is rugged and simple in construction, and has been especially designed for skidding and hoisting timbers; for handling equipment, materials, etc.; for hauling and spotting cars; and for single-cable slushing and other moderately heavy work requiring the use of a portable hoist that will stand up to the service expected of it and that can be shifted quickly and easily.

Like the other "Utility" hoists, the HU is equipped with a reversible, 4-cylinder radial-piston type air motor that has proved to be highly efficient on low air consumption. Adequate lubrication is assured all working parts; and ball or roller bearings are used throughout. A clutch of the jaw type engages or disengages the drum, which carries 550 feet of $\frac{3}{8}$-inch cable. The brake is of the external contracting type. The hoist, without cable, weighs 490 pounds; it is 32 inches long, 22 inches wide, and 23 inches high; and is firmly mounted on a heavy cast-steel plate. This plate is provided with holes and grooves that permit either bolting the hoist to a flat surface or clamping it to a column, as service demands may require.

The first museum in the United States to be given over to the story, so to speak, of steel has been opened to the public in Worcester, Mass. Chronological order has been observed in arranging the exhibits showing the prehistoric uses of the metal and bringing the development down through the ages to modern processes and typical products made of steel.

## ALUMINUM PAINT SUITABLE FOR CREOSOTED WOOD

A VEXING problem in connection with creosoted timber has seemingly been solved, according to *Wood Preserving News*, from which we learn that the efforts to find a satisfactory paint for wood so treated have at last borne fruit. Telephone poles, guard rails, and the like, are preferably painted white to make them conspicuous; but the paints heretofore used soon became discolored through the action of the contained preservatives.

A 2-year test with four different kinds of special paints—namely, a white cellulose-base paint, a green lead-base paint, a green zinc-base paint, and an aluminum paint—was recently concluded, and this revealed that the aluminum paint retained its bright silver finish to the end while the three others already showed some discoloration within from 60 to 90 days.

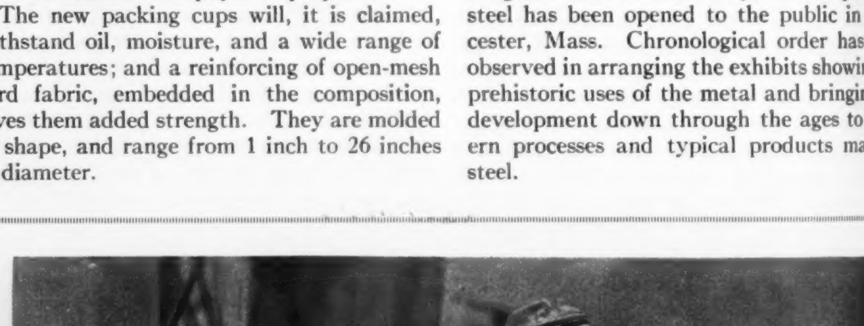
The paint that won out in the comparative test was recommended by the Aluminum Company of America. The vehicle was a hard dry long oil, varnish type, containing 50 per cent by weight of non-volatile oils and gum. The larger proportion of the vehicle consisted of heat-treated China wood oil and the remainder of heat-treated linseed oil. This sets to the touch in about two hours and dries hard in twelve hours. Aluminum powder was added at the rate of $2\frac{1}{4}$ pounds per gallon—the mixing being done on the job, as required.

It is reported from Shanghai, China, that a large iron deposit has been discovered south of Takhing by a group of mining experts sent out to prospect the mineral resources of western Kwangtung. An analysis is being made of the ore to determine the approximate value of the bed.

## IMPROVEMENT IN PACKING CUPS

A LINE of composition packing cups suitable for a wide variety of pneumatic devices such as operating valves, power and cushioning cylinders, hoists, chucks, clamps, air springs, etc., is offered the trade by the Westinghouse Air Brake Company. These cups are made of the same rubber composition as are those especially produced by that company for its railway air-brake cylinders and which have been found to possess superior mechanical and physical properties.

The new packing cups will, it is claimed, withstand oil, moisture, and a wide range of temperatures; and a reinforcing of open-mesh cord fabric, embedded in the composition, gives them added strength. They are molded to shape, and range from 1 inch to 26 inches in diameter.



Removing paint with sand blast from the cylinder of an airplane motor at the shops, in Brownsville, Tex., of the Pan American Airways.

# IS THE GASOLINE TAX BEING OVERDONE?

By W. E. FARRELL*

COLORADO, Oregon, and North Dakota were the first states in the Union to impose a tax on gasoline, the revenue to be derived from gasoline-driven vehicles using the nation's highways and to be expended for the building, improvement, and maintenance of our highways. This was in 1919, and the tax amounted to one cent a gallon. By 1929, ten years later, every state but New York, including the District of Columbia, had imposed a similar tax.

*President, Easton Car & Construction Company.

Until 1922 the tax was almost uniformly one cent per gallon; but in 1923 many of the states raised the rate to two and, in some cases, to even three cents. Then those states that had lagged behind came in line with an initial tax of two cents. When it was realized that the public accepted the higher tax it became a more common practice to increase the rate not one but two cents.

The whole story of the tax situation from the beginning down to the present, and what may be expected in the next few years if conditions continue to develop as they have in the past, is plainly told by the tables and charts accompanying this article. By reference to these it will be seen that the tax now ranges from two to six cents in the different states, with an average of 3.8 cents in 1930. That year the tax on gasoline yielded a gross revenue of $522,110,961, an increase of $73,927,712 over 1929. In 1931 the average will probably amount to 4.2 cents and, ac-

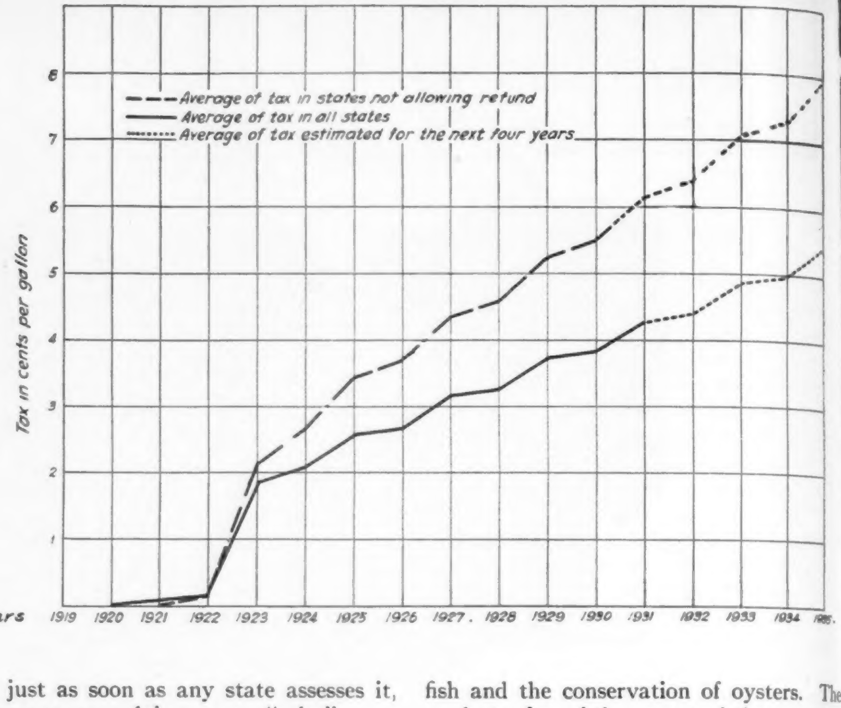
TAX ON GASOLINE

| | 1930 Cents | 1931** Cents | | 1930 Cents | 1931 Cents | | 1930 Cents | 1931 Cents |
|---|---|---|---|---|---|---|---|---|
| Alabama* | 4 | 6 | Maine | 4 | 4 | Ohio | 4 | 5 |
| Arizona | 4 | 5 | Maryland | 4 | 4 | Oklahoma | 4 | 5 |
| Arkansas | 5 | 6 | Massachusetts | 2 | 3 | Oregon | 4 | 4 |
| California | 3 | 3 | Michigan | 3 | 4 | Pennsylvania | 3 | 4 |
| Colorado | 4 | 5 | Minnesota | 3 | 4 | Rhode Island | 2 | 2 |
| Connecticut | 2 | 2 | Mississippi* | 5 | 5 | South Carolina* | 6 | 6 |
| Delaware | 3 | 3 | Missouri | 2 | 3 | South Dakota | 4 | 4 |
| District of Columbia | 2 | 2 | Montana | 5 | 5 | Tennessee* | 5 | 6 |
| Florida* | 6 | 6 | Nebraska* | 4 | 5 | Texas | 4 | 4 |
| Georgia* | 6 | 6 | Nevada | 4 | 5 | Utah* | 3½ | 4 |
| Idaho | 5 | 5 | New Hampshire | 4 | 4 | Vermont* | 4 | 4 |
| Illinois | 3 | 3 | New Jersey | 3 | 2 | Virginia | 5 | 5 |
| Indiana | 4 | 4 | New Mexico.* | 5 | 5 | Washington | 3 | 4 |
| Iowa | 3 | 4 | New York | 2 | 2 | West Virginia | 4 | 4 |
| Kansas | 3 | 3 | North Carolina | 5 | 6 | Wisconsin | 2 | 4 |
| Kentucky* | 5 | 5 | North Dakota | 3 | 4 | Wyoming* | 4 | 4 |
| Louisiana* | 5 | 5 | | | | | | |

Average tax for all states for 1930 amounts to 3.8 cents and for 1931 to 4.2 cents.

**No Refund Allowed.*
***Estimated.*

cording to one of the graphs, about 4.8 if not five cents by 1933. Some of the states may then perhaps be exacting a tax as high as eight cents; and, if past records are any indication, the increments will in all likelihood continue until by 1937 as much as eleven cents may be imposed in certain states on every gallon of gasoline bought within their confines. For the sake of clarity it should be understood that the legislators meet every other year and that most of the states which have been increasing the tax have met during the odd years. This accounts for the fact that the average aggregate increase in tax in the states concerned has been but seven cents during the even years and 21 cents during the odd years in the period 1923-1931.




In view of these conditions it is fair to ask: If there be a reason for these increases in tax, what, if any, will be the limit; and should all gasoline be taxed no matter for what purposes it be utilized?

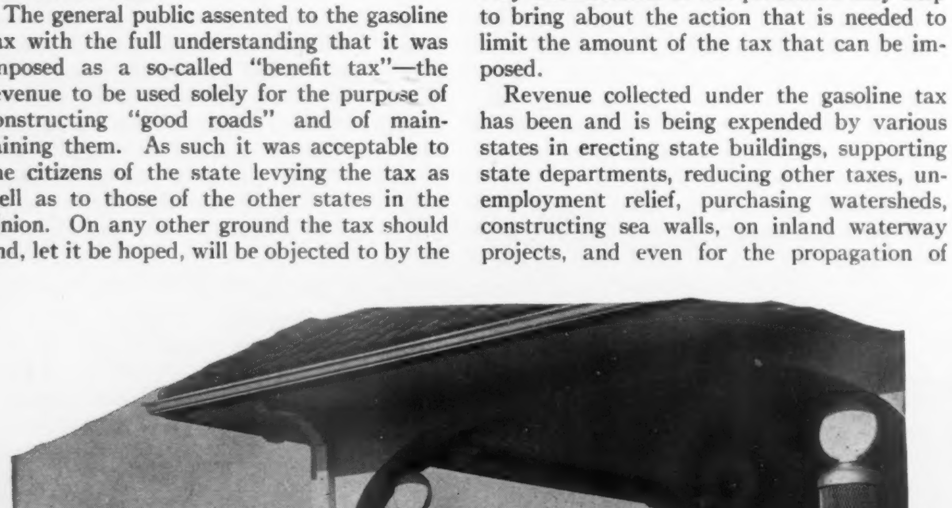
The indifference of the public is, without a doubt, largely responsible for these continual increases, and upon the public will rest the burden if nothing be done to limit the amount of the tax. If the people could be made tax-conscious, then a protest could be built up. Why should not every gasoline station be required to display prominently and separately the cost of the gasoline and the amount of the tax imposed thereon? When quoting a price on gasoline the tax is usually included, and on that account is rarely ever thought of as a separate item, if considered at all.

The general public assented to the gasoline tax with the full understanding that it was imposed as a so-called "benefit tax"—the revenue to be used solely for the purpose of constructing "good roads" and of maintaining them. As such it was acceptable to the citizens of the state levying the tax as well as to those of the other states in the Union. On any other ground the tax should and, let it be hoped, will be objected to by the people just as soon as any state assesses it, as some are now doing, as a "sales" or a "business tax" and applies the funds to such uses as it may see fit. The moment the revenue obtained in this way by a state is appropriated for other than road work, and citizens from other states are forced to contribute towards that revenue, it becomes a tax without benefit and, therefore, a tariff wall. The very offensiveness of the procedure may help to bring about the action that is needed to limit the amount of the tax that can be imposed.

Revenue collected under the gasoline tax has been and is being expended by various states in erecting state buildings, supporting state departments, reducing other taxes, unemployment relief, purchasing watersheds, constructing sea walls, on inland waterway projects, and even for the propagation of fish and the conservation of oysters. These are but a few of the uses; and the percentages so diverted vary. For example, in the first six months of 1930 one southern state appropriated 28 per cent of the tax obtained from the sale of gasoline for purposes other than roadbuilding and maintenance.

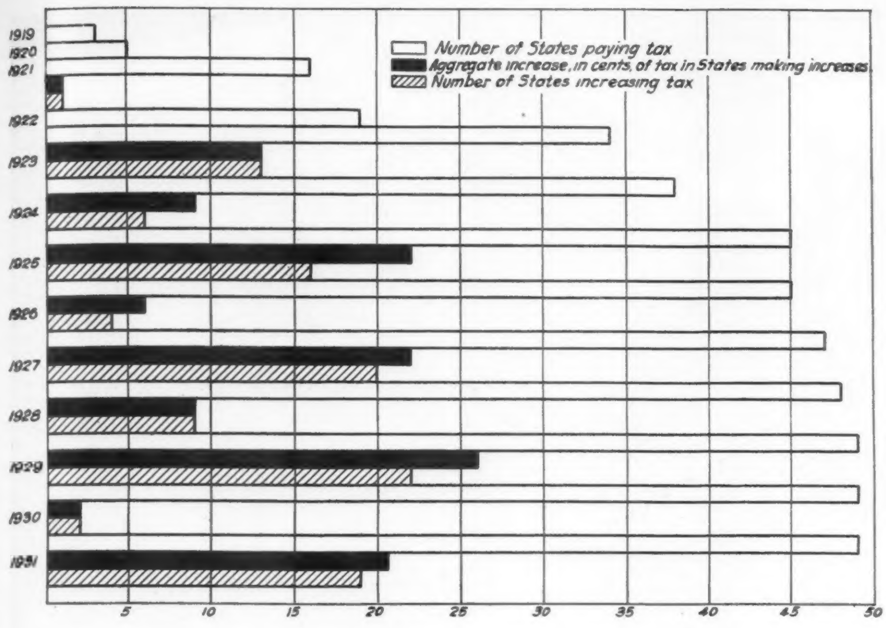
It might reasonably be asked if, after all, the tax is not, in effect, a per capita tax imposed on all individuals alike. Is it not possible that the poor man with the cheaper car may drive it many more miles and hence use just as much gasoline in a year as the man of means with his 6-, 8-, or 16-cylinder car? And the heavier car, it should be remembered, is harder on the road.

There seems to be no doubt that the tax was originally assessed and accepted by the people as a benefit tax. The intention was to derive from the cars and trucks using our highways the means wherewith to keep those highways in condition and to build new ones. It is therefore unjust to levy a tax on gasoline required for farming, industrial purposes generally, aerial navigation, for driving motorboats and ferryboats, etc., where gasoline must compete with other fuels such as coal, fuel oil, and electricity—fuels that are tax exempt. Should this become common practice, industry may be caused to discontinue the use of gasoline-driven machinery that has so widely supplanted machinery otherwise operated. Many instances could be cited of various kinds of stationary equipment—equipment that never comes in contact with our highways but that is, in certain of the states, nevertheless shouldering the steadily increasing tax burden which, in turn, increases the cost of production that must, inevitably, come out of the pocket of the ultimate consumer.



**One of the many thousands of filling stations where gasoline is dispensed**

Up to the present there are about a dozen states that have withdrawn the privilege of refund of tax on gasoline purchased for the purposes enumerated in the foregoing paragraph. Strange to relate, one of these particular states does allow a refund when the




| | Tax in Cents | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 2½ | 3½ | 4½ |
| Year | Number of States Paying Tax | | | | | | | | | |
| 1919 | 46 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1921 | 33 | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1923 | 15 | 13 | 13 | 7 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1925 | 4 | 3 | 21 | 13 | 4 | 1 | 0 | 1 | 2 | 0 |
| 1927 | 2 | 0 | 16 | 14 | 11 | 4 | 0 | 0 | 1 | 1 |
| 1929 | 0 | 0 | 8 | 9 | 20 | 8 | 3 | 0 | 1 | 0 |
| 1931 | 0 | 0 | 2 | 8 | 16 | 16 | 6 | 0 | 1 | 0 |

tax has been collected on gasoline to drive a motorboat, provided that boat is engaged in fishing. It is, however, not specified whether the fishing is to be for pleasure or for business.

Taking the states that do not allow a refund on gasoline for industrial and farm use, it will be noted by one of the charts that the average tax on gasoline in those states not only is higher than the average tax in all the other states but is increasing at a much more rapid rate. On the face of it, if one state after another is permitted by its citizens to withdraw the refund or exemption clause, there is every reason to expect still higher taxes that will raise the average for the country considerably.

It is probable that the amount refunded on gasoline for purposes other than motoring does not exceed 5 per cent of the total tax collected. Though apparently not large it is of the utmost importance that this refund be made. In answer to the claim that the expense attached to the handling of the refund is out of all proportion to the amount involved, New Jersey, Connecticut, Rhode Island, Massachusetts, and certain other states have satisfactorily met the situation by passing a law exempting gasoline from tax when that tax is not strictly speaking a benefit tax. In other words, the amount of the tax is not included in the purchase price when the gasoline is not to be used for the driving of motor vehicles.

Numerous agencies and associations in this country are opposed to the continual increase of the tax on gasoline and to its becoming a sales tax by the withdrawal of the refund or exemption clause. Such organizations should receive the encouragement and the coöperation of the people of the United States if a prohibitive tax is to be avoided.

In the last analysis, is this tax as now levied economically sound, and is its diversion as outlined equitable to those contributing to it? To the student of the subject the application of the funds for other than road work seems radically unwise, to say the least, and is calculated to arouse not only the opposition but the active antagonism of the hitherto decidedly patient public.

Colorado, with an average altitude of 6,800 feet above sea level, is the highest state in the Union

## PHOTO-ELECTRIC CELLS CONTROL CONCRETE MIX

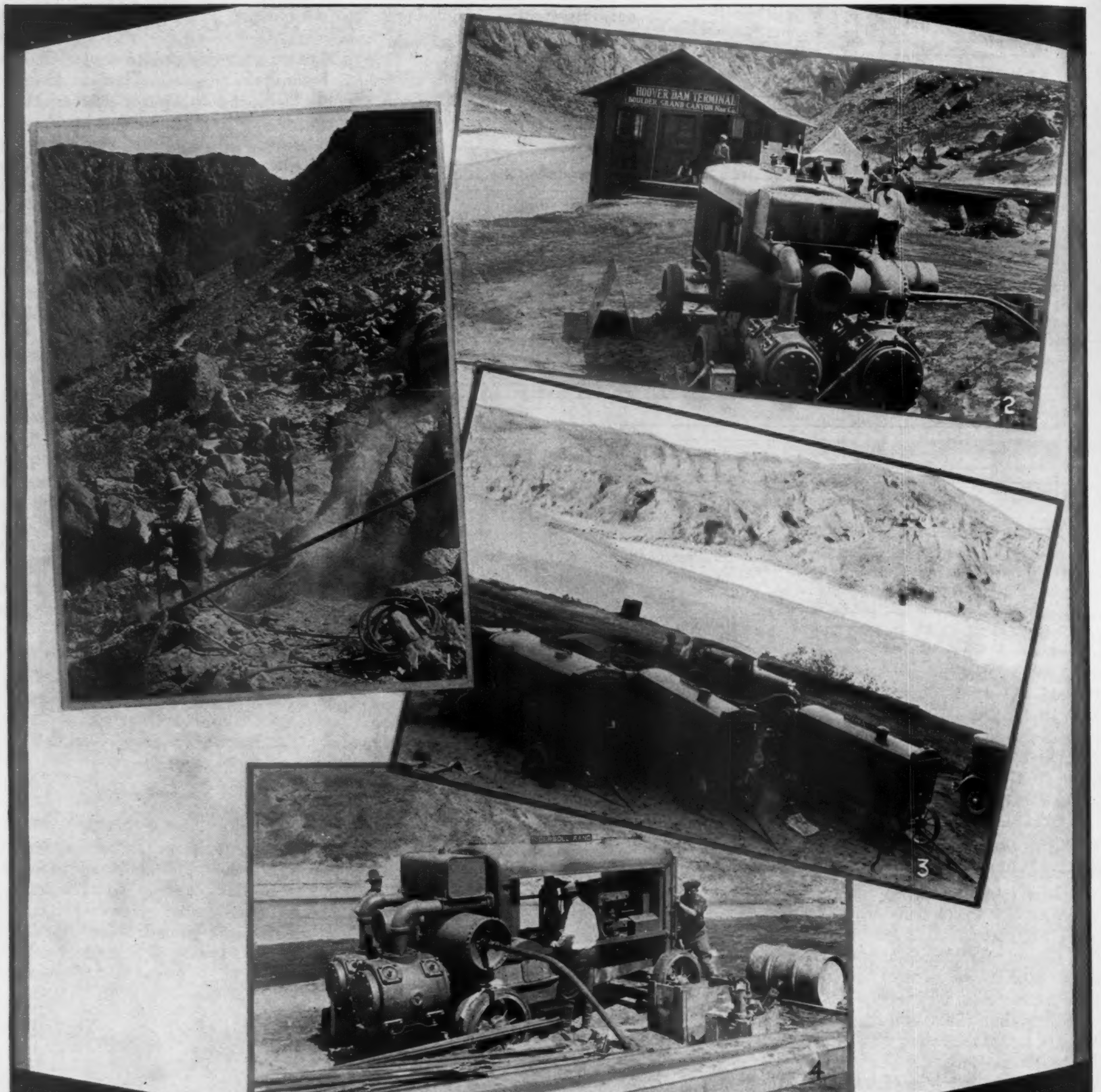
IN a recent design of a ready-mix concrete plant, the Stephens-Adamson Manufacturing Company has introduced an automatic control system of a new order that can be depended upon to measure out the different ingredients again and again with unfailing precision and with dispatch. Photo-electric cells are built into Toledo dial scales in such a way that the pointer of each scale swings between the associate cell and its exciting lamp. The photo-electric cell, as most of us know, responds to the slightest variation in light intensity and acts with the speed of electricity.

Each ingredient is brought from the storage bins to the mixing plant by conveyors that feed into weigh hoppers. The charging goes on uninterruptedly until the instant the pointers pass through the beams of light that are at all times focused on the cells. Promptly sensitive relays become active, amplifying the current sufficiently to operate the mechanisms that stop the flow of the water, cement, and aggregate—the cement and water being delivered into one weigh hopper and the coarse or fine aggregate into another. Each photo-electric cell can be set to act at any weight indicated on the scales.

With the watchful electric eye in charge of the proportioning, all danger of underweight or overweight is avoided, thus making it possible to produce concrete of a uniform grade no matter how many batches of a given mix have to be made up.

It has been estimated that there are 34,000,000 telephones in use throughout the world and that about 28,200,000 of those instruments can be hooked up with the Bell system in the United States. However, it should be added that the United States stands at the head of the list with approximately 20,000,000 telephones.

**Ease of replenishment makes users generally unmindful of quantities consumed**




**The start of a stupendous project. Preliminary work in connection with the great Hoover Dam on the Colorado River.**

## UTILIZATION OF BLAST-FURNACE THROAT DUST

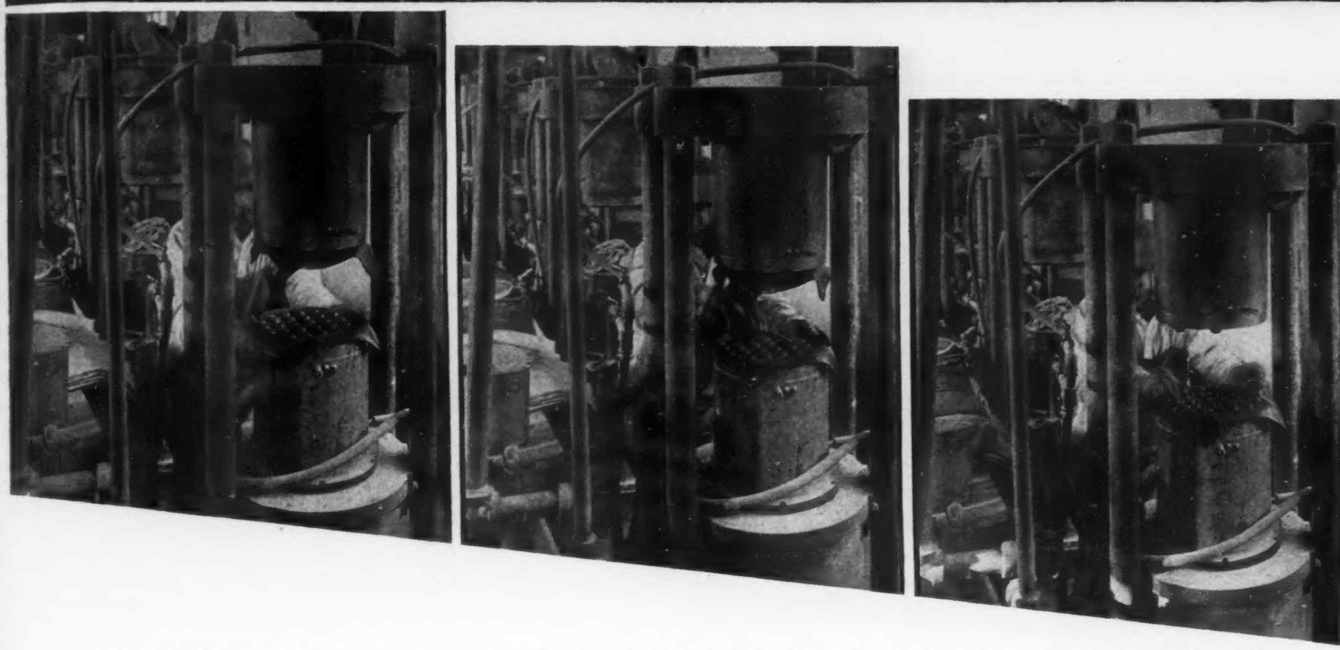
CERTAIN blast-furnace plants in Germany are making effective use of throat dust by a system that is said to be radically unlike any heretofore employed and is claimed to be a satisfactory solution of one of the blast furnaceman's most vexing problems. The quantity of the dust to be dealt with varies considerably in different establishments, and may range anywhere from 110 to 440 pounds for every ton of pig iron produced.

By the Heskamp method, the one under consideration, the throat dust is blown into the blast furnace through the shaft wall by the waste gas from the furnace without in anyway upsetting the balance of the charge. The waste gas is first purified and then compressed in two stages—the compressor delivering the gas at a pressure of from 57 to 100 pounds per square inch into a storage tank that supplies the blast-furnace feed tank. The gas being poisonous, it is necessary to provide against leakage by making the compressor gas-tight. This is done by the use of a special packing.

At one of the several works of the Vereinigte Stahlwerke, A. G., of Duisburg, that are equipped with the system, all the yield of coarse throat dust, approximately 15,000 tons per month, is being returned in this manner to six blast furnaces. The cost of the ore-and-flux mixture is thus considerably lessened; and, according to the company's records, the aggregate savings effected were soon sufficient to offset the capital invested in the gas-compressing and the dust-conveying plant.

For the first time in its history, the American Society for Testing Materials will sponsor an exhibit of testing apparatus and machines, together with associate recording and control instruments, in conjunction with the annual meeting of the society to be held in Chicago, Ill., from June 22 to 26. The display promises to be an interesting one, as it will include both domestic and foreign equipment as well as special apparatus used in private and Government laboratories ordinarily not available to the public.

# Making the Hearts of Modern Golf Balls



**From left to right these pictures illustrate the three stages in forming the spherical rubber centers for golf balls.**

THE sharp click, so dear to the golfer when club and gutta-percha impact, is the outcome of considerable scientific research and of a good deal of care in manufacture. Indeed, every ball is subjected to a sound test before it is packed by the maker for shipping.

The modern golf ball is radically different from the ball used for a long time by the original devotees of the "ancient and royal game". For something like 400 years—as those familiar with the history of the sport are aware—golf balls were made up of hand-sewed leather covers compactly filled with feathers; and it was not until a solid gutta-percha ball was introduced about 1850 that any substantial change came into being. A little later a small lead center was added to increase the specific gravity of the ball; and this innovation tended to steady the sphere while in flight.

Apart from its superior performance, a gutta-percha ball had this additional merit—it could be made and sold for much less than the historic feather-filled ball. This fact had much to do with popularizing the game by putting it within the reach of people of modest purses. The so-called solid gutta-percha ball held its own for nearly half a century; and it was not until 1899 that any radical improvement was made in its get-up. The betterments then effected were due to American inventiveness. What might be called the climax of the art was attained when various forms of liquid-filled cores were devised. Liquid-filled cores of numerous kinds have been invented, and for each some virtue has been claimed by those responsible for them. Golf balls with liquid centers are now made and sold in enormous quantities.

Without going into the refinements of the subject, it will probably suffice to say that golf balls of this kind lend themselves to nice control on the part of the player: it is possible with this type to obtain longer flights and greater steadiness while in the air than is practicable with a solid ball. It is also declared that a ball with a liquid center is less likely to be deformed by the blow of a club and, for that reason, will travel more nearly on a straight course. The explanation of this superiority of the liquid-filled center is that the fluid distributes instantly in all directions any pressure applied to it at a single point. Therefore, the reaction of the liquid, when the ball is struck, causes an equal pressure against every part of the confining elastic envelope and thus arrests any tendency of the ball to change its form from its normal spherical one.

Because of the prime part played by the little rubber shells that serve to hold the liquid centers, it may be of interest to the golfers among our readers to know how these rubber spheres are manufactured. To this end we shall have a look into one of the departments of the Stamford, Conn., plant of the Schavoir Rubber Company, where various types of rubber articles are turned out by machines designed by the members of that firm. These machines are actuated both by vacuum and compressed air; and pneumatic operation has distinctive virtues. The apparatus in service in the Schavoir plant are the result of much ingenuity and years of developmental work. The purpose of the equipment is to make it possible to supply the trade with products that can be turned out at relatively low cost, that are excellent in quality, and that have walls of uniform thickness throughout. This last attribute is essential in a golf-ball core, for if the rubber shells lacked in this particular the action of the liquid filling would be impaired when reacting to the pressure induced by the blow of a golf club.

In general terms, the rubber core shells are made up of two hemispheres that are united and caused to cohere by reason of the heat generated when pressure is applied at the moment union is effected. The hemispheres are formed from two sheets of rubber placed against the faces of molds set opposite each other in a press—vacuum being employed to suck the rubber into the hemispherical recesses of the two molds. Owing to the way in which this stage of the work is done in a Schavoir press, the plastic sheets are drawn into the mold recesses from rim to center so as to distribute the rubber uniformly against the surfaces of the forming walls. Some of our illustrations make this plain.

When the two sheets of rubber have been sucked into their respective mold recesses, then the operator puts a drop or so of water in each hemisphere in the lower mold. With this done, he turns a valve that admits compressed air to a cylinder—the air raising the lower mold and bringing it sharply and snugly against the mold above it. This movement serves to shear the rubber surrounding each cavity and to bring each pair of hemispheres forcibly together—the resultant heat uniting these perfectly and forming them into little balls that are what are known to the trade as "biscuits". The balls are dropped into shallow boxes and sprinkled with powdered talc to keep them from adhering to one another.

Some of our readers may wonder why the press could not be operated just as well with water pressure as with air pressure. Mr. Arnold L. Schavoir, in one of his patents, thus explains why air is preferred: "The air-actuated mechanism or air press is quicker and more positive in its action than the hydraulic press ordinarily employed. It builds

up power to exert a yielding blow in the final stage of the severing and the sealing operation. It produces a secure and more durable seal and, at the same time, occasions less wear upon the cutting edges of the knives".

The balls or core shells as they come from the forming press are smaller than they will be when finished and ready to be shipped to the golf-ball manufacturer, and, therefore, they must undergo further treatment. The first step of this treatment consists in placing the balls in metal molds that can be either heated by steam or cooled by water as occasion requires. Each mold is capable of holding a number of balls. When the steam-jacketed molds are closed and the steam is turned on, the heat causes the water previously put in the balls to vaporize and to expand so as to force the rubber spheres against the walls of the enveloping larger metal cavities; and the application of heat is continued long enough to cure the rubber and to give the balls the permanent set that makes them retain their increased diameter. At the proper time the steam is turned off, and water is admitted to the jackets of the molds to cool them. This chilling answers two purposes: it condenses the vapor in the balls and it cools the spheres so that they can be removed with the least delay from the molds.

The next stage of the work is directed to removing the little fin of rubber that projects at the equator of each ball just where the union of the wedded hemispheres was made. This is accomplished by tumbling the balls in a barrel lined with sandpaper. The final operation calls for the punching of two little holes in each ball. These holes provide, respectively, an inlet for air and an outlet for the contained water. The same holes serve, later on, for a reversal of this procedure when each small sphere is filled with the particular liquid used by the golf-ball manufacturer, who seals the holes after the ball has been duly charged with the chosen liquid. Then follow sundry and nice operations that make the finished golf ball as known to the devotees of the game.

**Type 15 vacuum pump used in connection with presses that make golf-ball centers.**

## ODORIZING NATURAL GAS FOR SAFETY

THE question of making natural gas malodorous as a safety measure has been much discussed latterly perhaps because of the increasing use of that fuel for both industrial and domestic purposes. Be that as it may, the United States Bureau of Mines has repeatedly stressed the importance of treating odorless gases so that a leak can at once be detected by the sense of smell. That these warnings are bearing fruit is brought out by the fact that the Pacific Gas & Electric Company, operating in California, has already put nine gas-odorizing stations in service along its 750-mile pipe line, and is contemplating the installing of three more to take care of new branch lines.

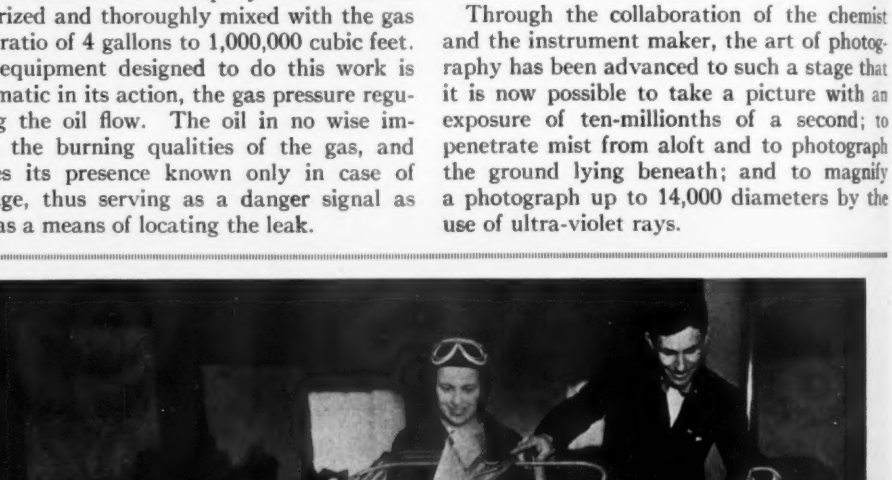
A distinctive odor is imparted to the natural gas by the addition of a special oil made by the Standard Oil Company. This oil is vaporized and thoroughly mixed with the gas on a ratio of 4 gallons to 1,000,000 cubic feet. The equipment designed to do this work is automatic in its action, the gas pressure regulating the oil flow. The oil in no wise impairs the burning qualities of the gas, and makes its presence known only in case of leakage, thus serving as a danger signal as well as a means of locating the leak.

## CABLEWAY IN INDIA SAVES HOURS OF TRAVEL

AERIAL cableways have become a recognized form of transportation in mountainous and other regions that are otherwise difficult of access. One of the newest of these, not long in service, presents a notable engineering achievement, and connects Kalimpong with Reang, in India. Kalimpong is a well-known hill station and a point of entry into India, and lies 3,300 feet above Reang, the terminus of the Darjeeling Himalayan Railway.

Heretofore, the only means of communication between these points has been a rugged and dangerous roadway, 12 miles long, that is negotiated by carts in from 18 to 24 hours, depending upon conditions. Now it is possible to make the journey in 1½ hours by the aerial system, which is 7½ miles long and is operated in two sections. The carriers have a capacity of 1,200 pounds and travel at 3-minute intervals. The tallest tower in the line rises to a height of 139 feet. The project was completed in eighteen months at a cost of approximately $162,000.

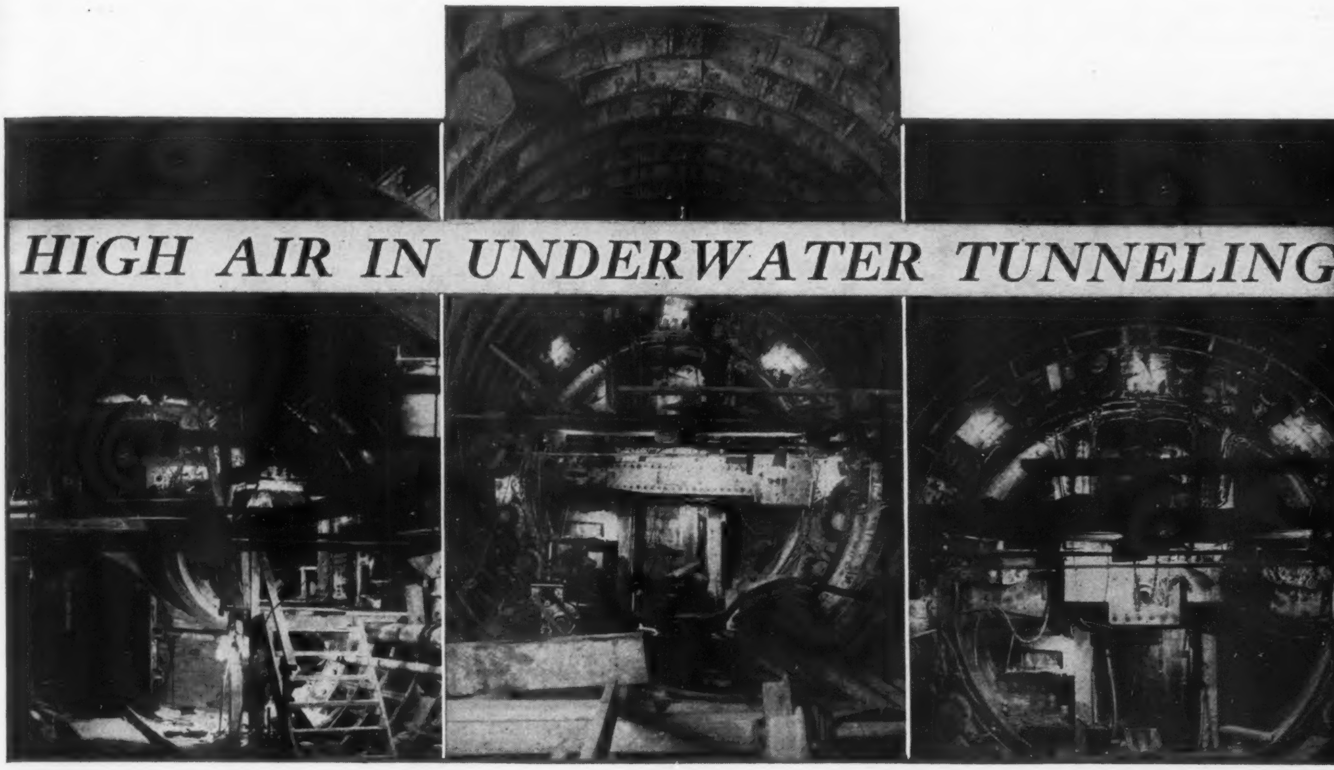
Through the collaboration of the chemist and the instrument maker, the art of photography has been advanced to such a stage that it is now possible to take a picture with an exposure of ten-millionths of a second; to penetrate mist from aloft and to photograph the ground lying beneath; and to magnify a photograph up to 14,000 diameters by the use of ultra-violet rays.



Photo, Acme-P. & A.

**This small model of an airplane is so pivoted that it can duplicate the movements of an aircraft in flight. This is effected by strong air streams that bring about reactions when the controls are operated. Thus a student can learn to fly without leaving the ground. The apparatus is one of the features of a school for air pilots in Seattle, Wash.**

# HIGH AIR IN UNDERWATER TUNNELING



*Numerous as These Subaqueous Routes Are Still the Means Employed to Drive Them Are Not Widely Known*

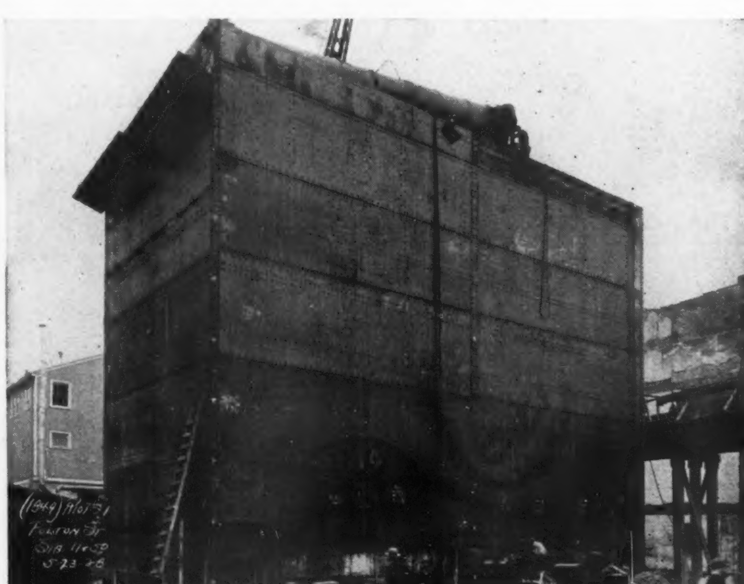
By CAMPBELL W. McNEILL

"HIGH air", in the language of the subaqueous tunnel driver, sums up in two words the conditions under which work of that sort is carried on deep beneath the level of ground water and the surface of some river, as a rule. The public generally is unaware of the circumstances in which engineering tasks of this kind are carried laboriously to completion; and relatively few of the people who ultimately profit by projects of this nature have any definite conception of the difficulties encountered, the hazards courageously faced, and the means employed to burrow in a seemingly blind fashion onward in the depths and yet forge ahead with extraordinary precision to the point where opposing shields meet so as to join the tunnel sections.

The purpose of the present article is to make the different essential operations understandable to the average layman; and the reason for reviving the subject is due to the fact that New York City is soon to begin the building of two more subaqueous vehicular tunnels—one linking New York and New Jersey under the Hudson River and the other joining the Borough of Manhattan with Long Island City, on the opposite side of the East River. Furthermore, the Metropolis has now under construction a subway tunnel that will extend, when finished, from Rutgers Slip in Manhattan to Jay Street, Brooklyn.

Suppose we go below with the "sand-hogs" and the city's inspector and spend a shift in a subaqueous tunnel. We get off the cage at the bottom of the shaft and walk toward a concrete bulkhead in which are set three air locks. The largest one, the muck lock, has narrow-gage tracks so that cars can be run in and out of it. The medium-sized one is the man lock, and the smallest is the emergency lock which is used only in case of necessity.

Stooping down we enter the man lock through a heavy, rubber-flanged door. The last man swings the door shut. The lock tender, sitting well forward so that he can see everyone, opens the intake throttle wide, and air from the tunnel comes roaring in making the chamber stuffily hot. The ear drums might be ruptured by the increased pressure unless they are relieved by pinching shut the nostrils and trying to blow through them. Unable to escape, the air will thus be forced into the sinus and the Eustachian tubes, alleviating the pain instantly.



**When this steel cofferdam is sunk to the prescribed depth it will serve as the point of departure for four headings—two advancing inland and two going out and under the river.**

If a man becomes "blocked"—that is, unable to relieve the ear drums, he signals by throwing up his arm, and the lock tender at once closes the valve. If still unable to clear himself, the lock is decompressed; he is let out; and his fellow workers proceed to the heading, for they must relieve the preceding gang on time. Although sand-hogs generally work very short hours—for instance, two 1-hour shifts in 40 pounds of air, they put more energy into those short working hours than most men on longer shifts. This is due, in part, to the extra oxygen in the air.

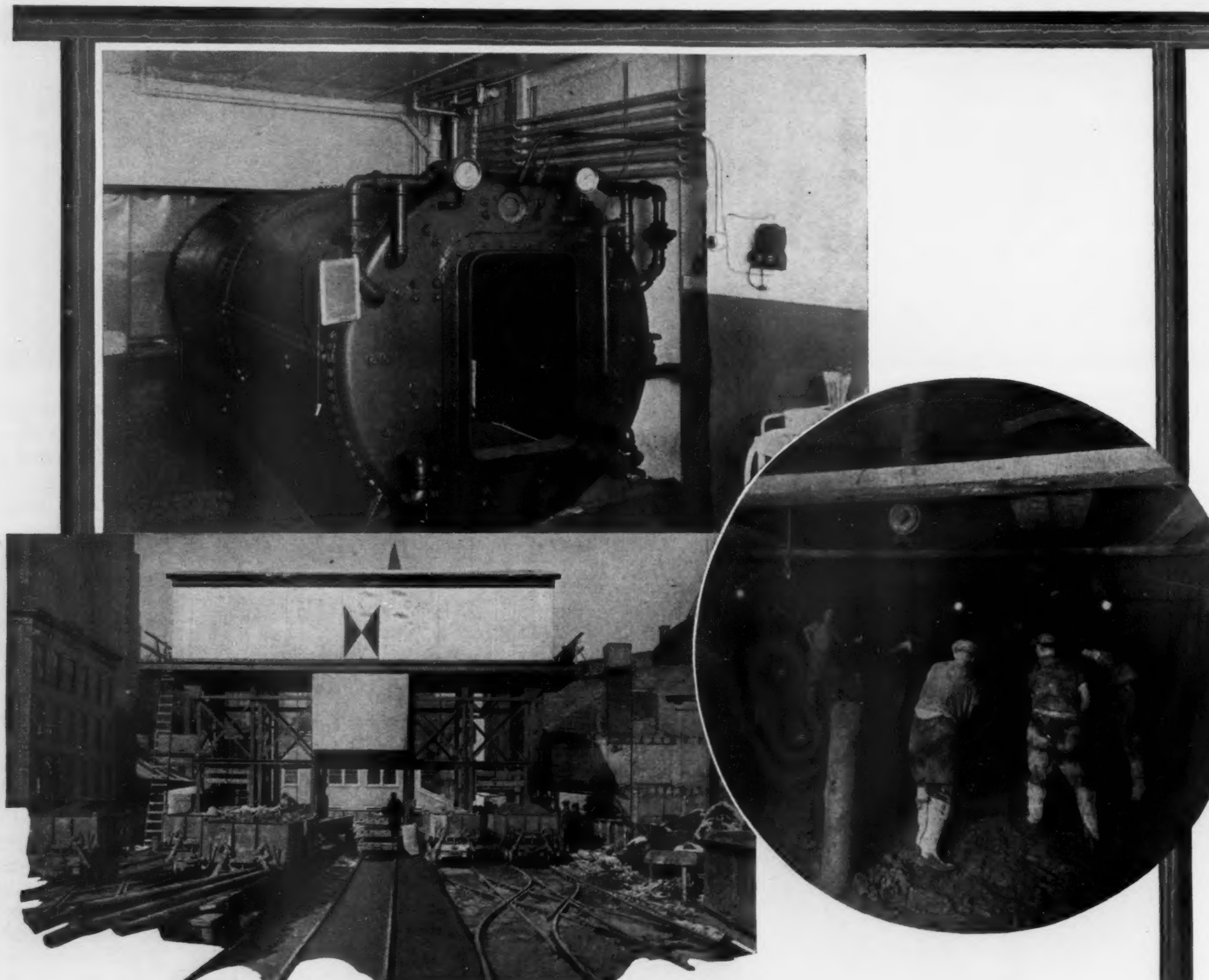
When the air pressure in the lock corresponds with that in the tunnel, the door leading to the heading is swung open. All doors open towards the

heading. Thus when a lock is being decompressed, the greater pressure in the tunnel keeps the door shut. The air in the tunnel is damp and cool. There is a slight fog which is due to the compression-heated air condensing on the cast-iron tunnel lining. A short walk down the tunnel brings us to a second bulkhead with its complement of locks. The bulkheads must not be more than 800 feet apart. During compression in the second lock the heat becomes almost unbearable; but in a short time we are once more in the chill, damp tunnel air.

Ahead of us is the shield, a huge metal cylinder divided in half by a horizontal platform and into smaller compartments vertically, each large enough for a man to work in. The shield driver stands on the platform and operates hydraulic jacks that force the massive cylinder forward through the ground. From this station, too, he controls the erector—a revolving arm that puts the heavy plates of the ring in place. The jacks are operated independently of each other, the shield being guided by the number and the position of the jacks used.

sary muck has been removed, depending on the hardness of the ground. Boulders too big to be excavated whole are block-holed and blasted. When the boards are in position, timbers are dropped in front of them and sliding tables moved forward to hold all in place. While mucking is going on the boards are temporarily held by screw jacks.

Two or three men are at each of the big ratchet wrenches that serve to bolt the ring plates together. The tops of the flanges are cast so that lead calking can be hammered in between the plates. Watertightness is a



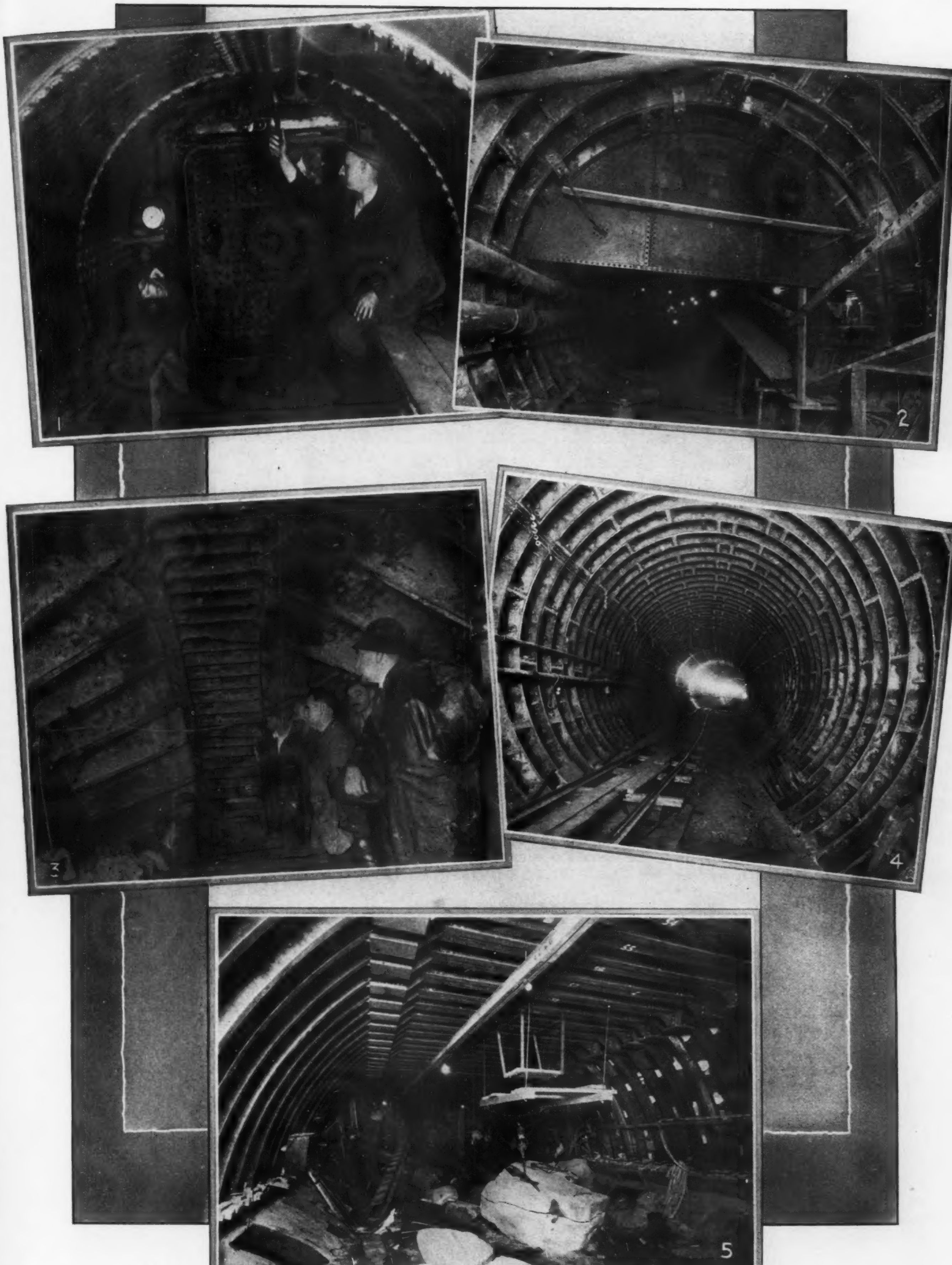
**Top—Hospital lock used for treating workers showing ill effects of exposure to high air pressure. Circle—Working chamber of big steel cofferdam showing cutting edge penetrating ground enveloping old cribwork. Bottom—Close-up of hoistways leading into shaft connecting with cofferdam from which tunnel tubes are being driven in two directions.**

Halfway up on one side of the tunnel is a runway wide enough for us to walk along. Within 200 feet of the heading it dips beneath a huge metal sheet that fits exactly into the upper half of the tube. This is a safety screen. On the side nearer the lock, slightly above the lower edge of the screen, is a high-pressure air line. If the river should come in, the water will open the valve, thus allowing the air to rush against the screen and to force the water back sufficiently so as to leave a breathing space for anyone luckless enough to be trapped. One lock must at all times be "in", with the door open, in case of emergency.

The work of mucking and of assembling the ring and tightening it goes on at breakneck speed. The miners toil away beneath an extension of the cutting edge of the shield that is called the hood or apron. This protects the men from the muck directly overhead. The face is mucked out almost in line with the edge of the hood, great care being taken to keep the face flat. Pockets are apt to cause a "blow" by disturbing the uniform pressure of the air on the face as a whole. A section 2 feet or so in depth is leveled all the way across the face and then boarded up. This procedure is continued until the neces-

necessity, and to this end four washers are used to each bolt. The inner two, the grommets, are of oakum soaked in red lead, the outer ones are of cast iron. The bolts are made as tight as two or three men with 5-foot wrenches can make them, thus forcing the grommets into the bolt holes and sealing them.

When the leading ring has been so tightened, then the second and the third rings back are gone over again to retighten any bolts that may have loosened during the "shoves". In this way each ring is gone over three times, and before each shove the iron must be passed



All photos, courtesy Board of Transportation, New York City

**1—Lock tender controlling air pressure preparatory to opening the door near him. 2—Safety screens are placed in the upper segment of the tunnel at prescribed intervals. 3—The cutting edges of shields, advancing from opposite directions, just before coming together. 4—Finished steelwork in a section of subaqueous tunnel. 5—Here the tunnel workers are excavating the ground between two adjacent tubes preparatory to constructing the central platform at a station.**

**Left—Hoistways above cofferdam used to deliver materials underground or to bring muck, etc., to the surface for disposal.**

**Right—Pier facilities for discharging excavated materials into barges for carriage to dumping points.**

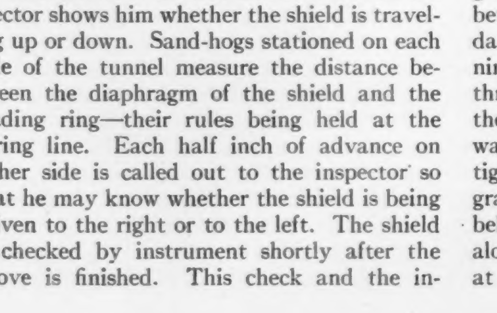
by an inspector. This is done by running a thin-bladed putty knife along the side, top, and bottom joints of all the plates in the leading ring above the flooring and by testing each bolt to see that it is tight. The plates must be "iron to iron" at every joint—that is, so closely bolted that the putty knife cannot be inserted anywhere. The bolts are tried with a wrench or by tapping, as rivets are tested.

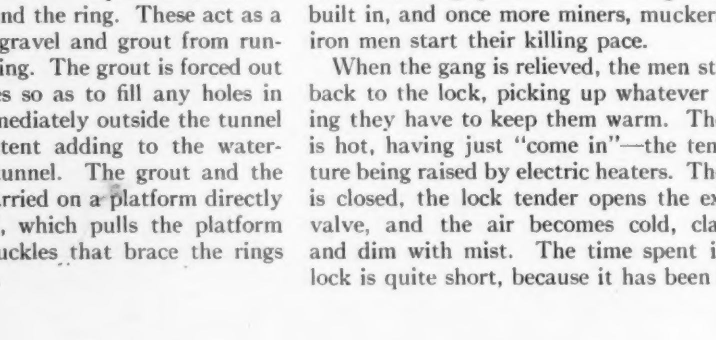
With the iron passed, the inspector gives orders for the next shove. He pulls a horizontal rod out from the shield to a given point, and from that rod drops a plumb line. The distance between the line and a button on the erector shows him whether the shield is traveling up or down. Sand-hogs stationed on each side of the tunnel measure the distance between the diaphragm of the shield and the leading ring—their rules being held at the spring line. Each half inch of advance on either side is called out to the inspector so that he may know whether the shield is being driven to the right or to the left. The shield is checked by instrument shortly after the shove is finished. This check and the inspector's report are compared, and from them the next shove is plotted. While the forward movement is in progress the miners stand within the shield ready to take care of any emergencies.

After each shove, gravel is shot through the plug holes in the bottom plates of the second ring back to fill in any cavities and to keep the iron from settling. The tail of the shield extends back far enough to encircle the first ring and about half of the second ring. Broken plates in the first ring can be removed at this time, replaced by perfect ones, tightened, and passed. At this stage of the operations gravel bags are torn in strips and driven in between the tail and the ring. These act as a dam to keep the gravel and grout from running out and wasting. The grout is forced out through the plates so as to fill any holes in the formation immediately outside the tunnel walls, to that extent adding to the watertightness of the tunnel. The grout and the gravel pans are carried on a platform directly behind the shield, which pulls the platform along over turnbuckles that brace the rings at the spring line.

In the meanwhile the inspector has been taking some measurements to guide him in assembling the ring. The vertical, horizontal, and diagonal diameters are recorded, as are also the clearances between iron and tail at those points. The distance that the top of the ring is advanced over the bottom, or *vice versa*, is likewise noted. After the bottom back iron has been passed, the flooring and the tracks are laid. Then three or four plates are dropped in the bottom, tightened up, passed, and their joints calked. The 3- and 4-plate bottoms alternate so that the cross joints of two consecutive rings do not come together. The remaining plates of the ring are now built in, and once more miners, muckers, and iron men start their killing pace.

When the gang is relieved, the men straggle back to the lock, picking up whatever clothing they have to keep them warm. The lock is hot, having just "come in"—the temperature being raised by electric heaters. The door is closed, the lock tender opens the exhaust valve, and the air becomes cold, clammy, and dim with mist. The time spent in this lock is quite short, because it has been found




**Left—Typical concrete bulkhead with locks such as are installed at intervals when driving a subaqueous tunnel. Right—Longitudinal section of some of the principal features of a shield used at the heading of an underwater tunnel.**

beneficial to take a quick decompression at the start in order to create a partial vacuum in the body. The walk between locks also helps the body to rid itself of surplus air. Here, between locks, men surreptitiously light pipes or cigarettes. Smoking being forbidden, they are careful not to let the inspector, or others in authority, see them. The fire hazard is greatly increased by the excess oxygen in the air.

In the second lock the decompression period is much longer, usually one minute for each pound of pressure at the heading. Sleep, talk, and card games are all popular diversions with the sand-hogs to help pass the time. An incident that occurs occasionally while the men are in this lock never fails to cause a great deal of merriment to everyone but the victim. Above the subdued voices there is heard a sharp click of breaking glass followed by the smell of liquor. Talk and card games are forgotten as all eyes are turned to enjoy the storm of wrath poured forth by their thoughtless companion. A bottle should be uncorked both during compression and decompression, otherwise the unequal pressures will break the glass and spill the contents on the owner. Drinking, like smoking, is forbidden, but both go on to some extent.

Compressed-air workers must wear on their street clothes a small metal badge bearing the following inscription: "Compressed air employee. If ill rush by ambulance to hospital located at 'Blank and Blank' streets. By order of Ambulance Board." At the designated hospital—the doctor's office at the tunnel shaft—there is a small lock divided into two compartments so that two patients can be treated at one time but at different pressures, if need be. In each compartment are a bed, a telephone for communicating with the doctor or nurse, and a set of control valves. The air pressure can thus be regulated from the outside as well as from the inside.

"Bends" is the most common ailment, and may prove fatal. It is caused by the body not completely ridding itself of the excess gases absorbed by the blood during the period of compression. Although bends may affect any part of the body, the malady occurs most frequently at the joints. Relief may be obtained by again subjecting the patient to air pressure.

"Staggers" and "blind staggers" may also attack the workers. In the case of the former the victim appears to be intoxicated; in the second, he not only has all the symptoms of a drunken person but his sight is temporarily lost. When in such condition it would be useless, perhaps fatal, to take the sufferer to the wrong hospital where the illness might be improperly diagnosed and where there are no suitable facilities for dealing with this special physical condition.

But with all the disadvantages, and there are many, when there is a "high-air" job the sand-hog will leave whatever else he may be doing to go beneath the river bed to toil like one demented, for air jobs are few and far between, and they pay unusually well.

## FRESHNESS OF EGGS PRESERVED BY OILING UNDER VACUUM

WITH the combined use of a vacuum chamber, a small quantity of mineral oil, and a high-pressure tank full of carbon dioxide, a bacteriologist of the United States Department of Agriculture can, it is authoritatively reported, preserve the freshness of eggs for nearly a year in cold storage.

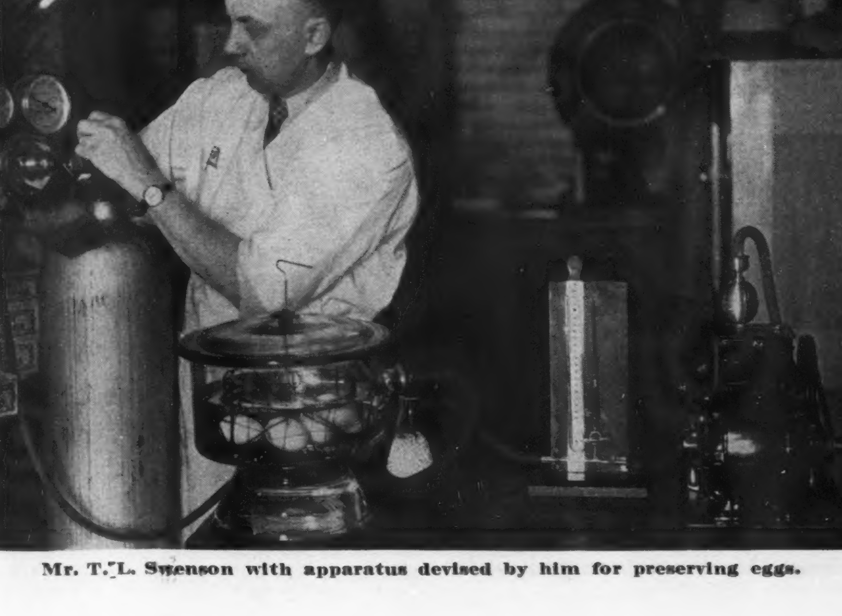
The treatment that assures this is simple enough, and is achieved in three successive stages. The fresh eggs are placed in a wire basket and lowered into the airtight vessel, which is then closed. This vessel has in it just enough of the mineral oil to completely cover the eggs. The next step involves creating a partial vacuum not only in the chamber but likewise in the eggs by exhausting some of the contained air. By means of a projecting wire handle the basket of eggs is lifted clear of the oil bath to drain. This finished, the treatment is concluded by permitting carbon-dioxide gas from the pressure tank to flow into the sealed vessel.

Mr. T. L. Swenson, the bacteriologist in question, observed with interest the benefits derived from dipping eggs in oil before putting them in cold storage, a practice started a few years ago by individuals in the egg trade. He noticed that the oil served to close the pores of the shell and to prevent loss in moisture and carbon dioxide, the chief cause of spoilage. He reasoned that if a superficial coating could reduce spoilage to the extent it apparently did, why, then, should it not be possible to still further reduce the losses by making the oil penetrate more deeply into the shell? This he succeeded in doing most satisfactorily by the aid of the carbon dioxide, which flows in through the shell of the evacuated egg carrying the oil with it—the oil acting as a seal and effectually keeping the gas confined within the shell. It is well known that carbon dioxide protects foodstuffs against bacterial attack; and the amount of the gas within the shell determines the length of time, within limits, an egg will retain its freshness in storage.

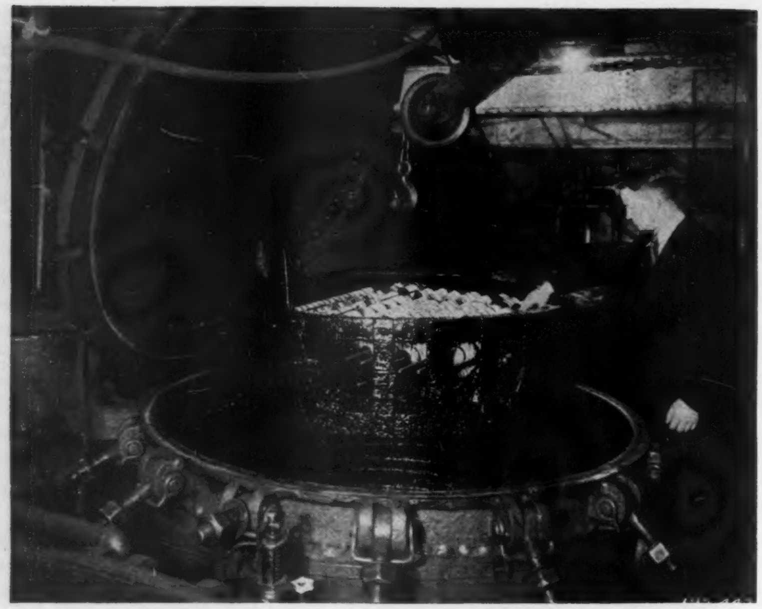
Comparative tests at the Department of Agriculture have disclosed that the vacuum-dipped and carbonated egg lost but one-tenth of one per cent of its weight in ten months of storage. On the other hand, the egg oiled under normal atmospheric pressure lost sixteen times as much in the same interval, while the unoiled egg lost 77 times as much weight, represented chiefly by the escape of carbon dioxide and moisture. Judged by quality after storage, an expert grader found that of the eggs used for test purposes—including the unoiled, the dipped, and the vacuum-treated product, by far the largest percentage classed as the "better-market grade" consisted of eggs that had been subjected to the Swenson process.

Last December there were in cold storage about 5,000,000 cases of eggs, on which the current price per dozen was eleven cents less than that asked for fresh December eggs. With this figure as a basis of computation, it can be readily grasped what the new process would mean in dollars and cents to the trade if it were possible, as the Department of Agriculture believes it is, to bring the price of storage eggs more nearly up to that of the fresh commodity. The department has a public-service patent on the method of treatment; but to date no commercial machine embodying the principles has made its appearance.

According to the Director of the United States Bureau of Mines, there is a marked trend in the western diatomite industry towards a more complete mechanization of the operations. Open-pit quarrying is giving way to underground mining methods; the mineral is being handled in the stopes by means of air-powered scrapers; and the material is delivered through chutes to a main haulage tunnel whence it is taken to mechanical driers.



**Mr. T. L. Swenson with apparatus devised by him for preserving eggs.**



Lowering a basket of electric coils into the insulating tank developed by J. T. Goff of the Westinghouse Research Laboratories.

## IMPROVED METHOD OF INSULATING ELECTRIC APPARATUS

AN invention that it is estimated will save the electrical industry more than $1,000,000 annually has recently had its first practical test at the East Pittsburgh works of the Westinghouse Electric & Manufacturing Company. It concerns a new insulating material as well as a new process for applying that material, and affects, so it is said, wellnigh every department of the industry.

By the method, the solventless varnish, as it is termed, is made to entirely fill the pores of the fibrous material between the wires so that it actually becomes a solid and an integral part of the electric apparatus, whether it be a tiny clock motor or a giant motor, a circuit breaker or an enormous generator that supplies light and power.

Impregnation is effected as follows, and in much the same way that timber is creosoted: The coils, for example, to be insulated are placed in a metal basket and lowered by the aid of an air hoist into a special tank equipped with a heavy quick-closing cover. This cover is clamped down airtight, and a high vacuum is induced so as to exhaust the air in the tank as well as that confined within the particular electric apparatus to be treated. In the meantime the varnish has been heated in another tank to make it flow more easily. When everything is in readiness, atmospheric pressure forces into the evacuated tank enough of the varnish to cover the contents. Then the supply is cut off and an inert gas pumped into the tank under considerable pressure, causing the varnish to penetrate into the innermost recesses of the windings of the coils. There they are allowed to remain for several hours, any excess varnish being subsequently removed by draining.

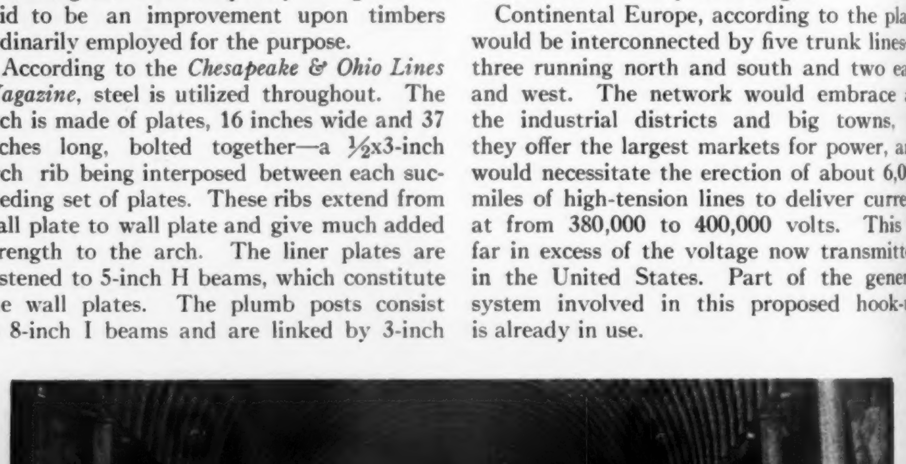
Tests have shown conclusively that the process assures thorough impregnation and that it prevents the formation of undesirable air pockets. As a consequence, the insulation not only offers more resistance to moisture but its life is increased measurably. From the standpoint of production, the method of application makes it possible, so it is claimed, to cut about one-fifth from the present factory cost of impregnation.

## STEEL INSTEAD OF TIMBER IN TUNNEL WORK

IN driving an east-bound railway tunnel parallel to the Big Bend Tunnel between Talcott and Hilldale, W. Va., the contractor is making use of a temporary lining that is said to be an improvement upon timbers ordinarily employed for the purpose.

According to the *Chesapeake & Ohio Lines Magazine*, steel is utilized throughout. The arch is made of plates, 16 inches wide and 37 inches long, bolted together—a ½x3-inch arch rib being interposed between each succeeding set of plates. These ribs extend from wall plate to wall plate and give much added strength to the arch. The liner plates are fastened to 5-inch H beams, which constitute the wall plates. The plumb posts consist of 8-inch I beams and are linked by 3-inch struts centrally disposed between the wall plates and the subgrade. The plumb posts are set on 6-foot 2-inch centers, although the wall plates are drilled midway for an additional post.

There are several reasons for the use of steel, says the assistant chief engineer of the Chesapeake & Ohio. It is more easily and, therefore, more quickly erected than timber; and it assures an arch of more even surface than when 12x12-inch timber segments are utilized. The steel wall plates and plumb posts are encased in the concrete lining, thus serving the dual purpose of temporary support and permanent reinforcing. About 30 per cent of the liner plates are drilled with holes to permit grouting back of the arch, if desired. The new tunnel will have a length of 6,200 feet; and the work of driving it is going forward at a rapid rate.

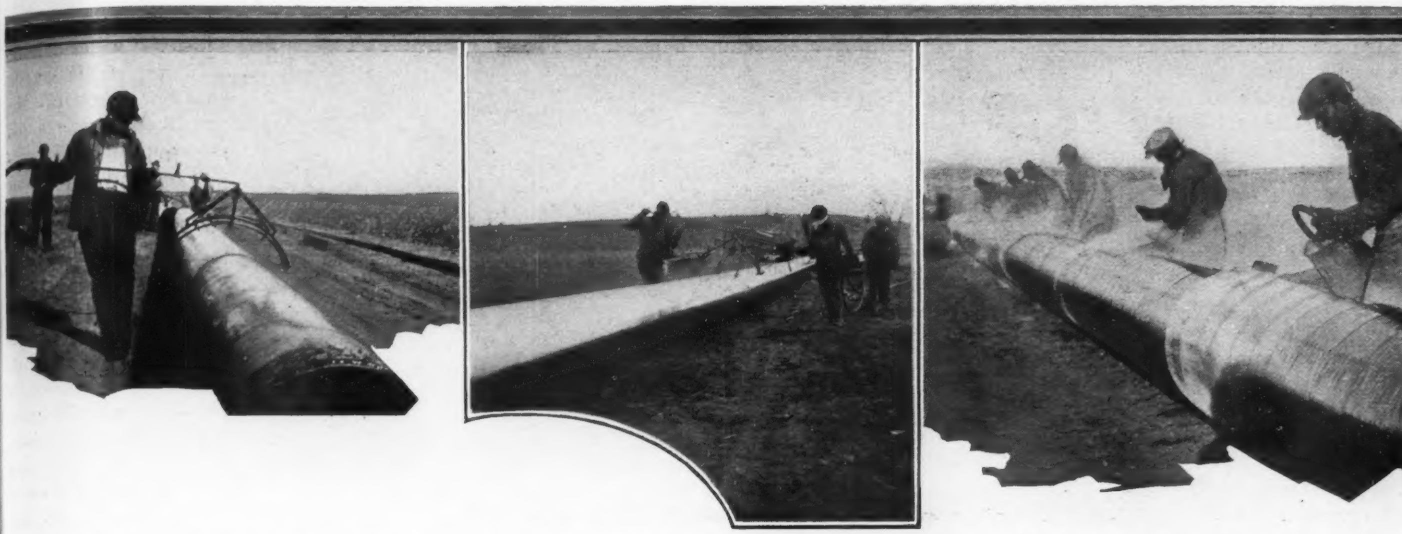



At the heading in the east-bound unit of the Big Bend Tunnel showing the temporary steel lining in place.

## PROPOSED PAN-EUROPEAN SUPERPOWER SYSTEM

AN interesting development of the World Power Conference is the contemplated pooling of electricity in Europe—the linking up of the water-power and the coal-, the lignite-, and the oil-burning plants of all the countries so that the surplus at one point may be available for use at another where the load is temporarily in excess of the supply. Normally, of course, the energy would be consumed in the country of its origin.

Continental Europe, according to the plan, would be interconnected by five trunk lines—three running north and south and two east and west. The network would embrace all the industrial districts and big towns, as they offer the largest markets for power, and would necessitate the erection of about 6,000 miles of high-tension lines to deliver current at from 380,000 to 400,000 volts. This is far in excess of the voltage now transmitted in the United States. Part of the general system involved in this proposed hook-up is already in use.



Left—One-man type of Binks pipe-painting outfit. Center—Two-man model of Binks pipe-painting outfit. Right—A 24-inch pipe line being given the additional protection of a spiral wrapping of paper which serves to cover the coating of coal-tar enamel.

# Pipe-Line Coatings Applied Pneumatically

PIPE lines for the transportation of petroleum have been in service for a goodly period of years; but pipe lines for the distribution of gas and even gasoline over long distances are relative novelties. Pipe lines for the conveyance of natural gas have been built at an astonishing rate in the last few years; and, besides affording new and far-flung markets for the gas, they have brought to users of many sorts a superior and an extremely moderate-priced fuel.

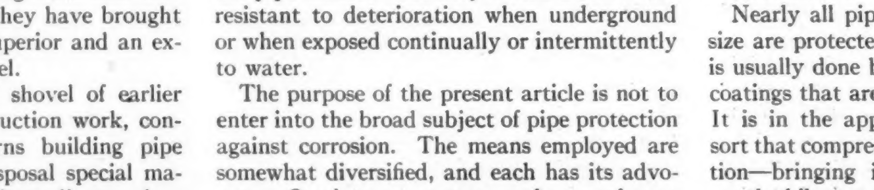
Instead of the pick and shovel of earlier days in this type of construction work, contractors and other concerns building pipe lines now have at their disposal special machinery that make it possible to dig trenches, to join long sections of pipe, to lower these conduits into the trenches, and to backfill the excavations with notable rapidity. It does not seem to make much difference, except for momentary slowing up of progress, what type of ground is encountered. Level stretches of dry land, marshes, rivers, creeks, hills, and even rocky routes are attacked without hesitation—the constructors keeping virtually to a predetermined and generally straight line in linking the system with wells and compressor stations and thence with points of consumption.

For a considerable period after enterprises of this sort were taken in hand little if any heed was given to the problem of protecting the buried piping from the corrosive action of the enveloping soil and the destructive effects of water. The matter compelled attention, however, when rust and pitting ate away at the piping and led to leakage and at times to collapse. Oil or gas escaped in large quantities, occasioning not only heavy losses but serious interruptions of service. Then it was that the engineering fraternity began to study the effects of different soils and set about discovering ways of coating the pipe lines so that they would be far more resistant to deterioration when underground or when exposed continually or intermittently to water.

The purpose of the present article is not to enter into the broad subject of pipe protection against corrosion. The means employed are somewhat diversified, and each has its advocates. Our interest centers on the use of compressed air as an aid in this field of protective work. Compressed air in pipe-line construction has been steadily finding wider applications. It is indispensable in drilling rock that must be cleared away in keeping the trenches on a given line and at a prescribed depth; and compressed air is utilized in a number of ways in assembling pipe sections, in pumping, and in doing other recognized essential things in connection with them. It is only recently, however, that compressed air has been put to a still newer service and, as in other instances, as a means of saving both time and money. This departure in practice has been particularly noticeable of late during the building of certain large natural-gas lines in the Southwest.

Nearly all pipe lines of this character and size are protected against corrosion, and this is usually done by covering them with heavy coatings that are compounded from coal tars. It is in the application of materials of this sort that compressed air finds its latest adaptation—bringing in its train substantial and worthwhile economies. As in the painting of other structures, a priming coat is first put on to provide a base to which an outer coating will all the better adhere. In the past, the usual manner of applying the priming coat has been with brushes. Now, on the other hand, spray-painting equipment is being used to do this work in certain of the mills manufacturing the pipe and also in coating the pipe just before it is put in the ground. Several concerns produce spray outfits for this service.

One of the more generally employed of such apparatus consists of a light carriage upon which are mounted spray nozzles supplied with air from a nearby portable compressor. This carriage is moved along on top of the pipe and travels on knife-edged wheels. The passage of the spraying equipment from end to end of a given section serves to cover about one-third of the surface of the pipe, and there-



Until recently this was the method generally employed in applying and spreading the protective coating on pipe lines.

four three trips of the carriage are required to completely coat that section. The spray nozzles are adjustable. They may be raised or lowered according to the size of the pipe that is being coated. Also, it is often found desirable when a high wind is blowing to bring the nozzles closer to the surface so as to prevent wastage of the coating material.

A Type Thirty portable compressor furnishing air for paint-spraying outfits used on a pipe line in Texas.

The next operation in thus protecting the pipe is to apply a final coat of coal-tar enamel. For this purpose many contractors prefer a type of equipment known as "rolling rigs". These are patented by the Wailes Dove-Hermiston Corporation, who make widely known bitumastic coatings. The pipe to be covered is mounted at each end on sets of rollers which, in turning, cause the pipe to rotate. It is in this operation that compressed air finds its second important new application in this field of service—the air being the force that turns the rollers through the medium of pneumatic motors. Inasmuch as a single pipe section for a large natural-gas line may weigh from 8,000 to 10,000 pounds, it can be readily realized that the work of rolling may impose a decidedly heavy duty on the equipment utilized.

It has been determined after much experience that compressed air is the best motive medium for driving these patented rolling rigs in applying bitumastic enamel; and these outfits make it possible to do this essential work easier and more uniformly than was practicable previously. In the language of a man intimately identified with the coating problem: "Compressed air, because of the mobility of the compressors used, the simplicity of the pipe-rolling motor, and the certainty of speed control permissible, has been found singularly suitable as a driving force. Ingersoll-Rand AASE motors are used as the prime movers of these rolling rigs". When a pipe has been coated in the manner described with bitumastic enamel, the surface has a high gloss and bears the distinctive spiral marking that is characteristic of coatings applied with the aid of these particular rolling rigs.

In some cases it has been found desirable to protect the coal-tar enamel by a spiral wrapping of paper or felt. Then compressed air is needed again to actuate the rolling rigs so as to facilitate the application of the paper. This obviates passing the paper around a stationary pipe, and it also produces a better, tighter, and more uniform winding. The paper or felt comes in rolls 18 inches wide and 100 or more feet in length. One operator holds the roll by means of a rod passed through the center of the roll while another worker attaches the end of the strip to the pipe. With this done, the throttle of the air motor is opened, and as the pipe rotates the paper is unwound from the roll and laid snugly on to the adhesive coating already in place. So covered, the piping is ready to be lowered into the trench and buried, and, because of the precautions taken, just that much better able to give a longer period of useful and unimpaired service.

## FIRE-FIGHTING IN METAL MINES

At the instance of the National Fire Protection Association and the American Mining Congress, provisions have been written into the American standard code for fire-fighting in metal mines that are intended to give men anywhere below ground instant warning of the danger threatening them. They prescribe that such mines be prepared at a moment's notice to spread through the workings by way of the ventilating system, and at the rate of thousands of cubic feet a minute, a highly disagreeable and searching odor; and, if electrically lighted, that all lamps be flashed nine times in three series of three flashes each. The latter is a supplementary alarm, as the power plant is not always to be counted upon in an emergency.

**Left—Air-operated pipe-rolling rig developed by the Wailes Dove-Hermiston Corporation.**

**Right—Mobile apparatus of many kinds are now used in building long-distance pipe lines.**

**The docks that have served Callao since about 1880.**

# Historic Callao Now Has Improved Harbor

## *This Peruvian Port Has Big Marine Terminal Planned and Built by an American Firm of Contracting Engineers*

By A. S. TAYLOR

CALLAO is in a fair way to recover her erstwhile importance as the outstanding port on the west coast of South America, thanks to recent substantial betterments. These improvements naturally revive interest in those days when Callao was the only open port on the coast south of Panama and enjoyed certain distinctions that made her noteworthy among mariners the world over.

Callao as a port was founded by Pizarro as far back as 1537—two years after that redoubtable freebooter conquered Peru and established Spanish rule over the empire of the Incas and called Lima into existence as the seat of the new government. History tells us that Pizarro and his followers had attacked the country because of the reputed wealth of gold possessed by the Incas; and if history be correct those ravagers were richly rewarded—carrying back to Spain in precious metals the equivalent of many millions of dollars. Callao, about eight miles west of Lima, served Pizarro, as well as the other Spaniards that came after him, as a haven for the vessels essential in maintaining contact with the mother country; and from that port was shipped the treasure garnered by the Incas during their rule of three centuries or more. Conversely, into Çallao were carried subsequently the manufactured products of Europe and of the United States.

Needless to say the Spaniards were not left in undisputed sway over Peru. During the latter part of 1578 Sir Francis Drake made his appearance in the bay upon which Callao is situated; and, after taking toll of that port, he sailed back to England with an abundance of plunder. Because of that visitation Callao was fortified and made sufficiently strong to repel a Dutch fleet that appeared there in 1624. In those days privateers were little better than pirates in their practices, and Callao had to maintain her defenses to hold her own against these predatory mariners. Accordingly, the Spanish government, about 1775, built the old fort on the point that shelters the harbor at the south and west. It served to safeguard against the fighting craft of envious European powers; and this selfsame fort in time was put to a more peaceful purpose—becoming the custom house of the port and remaining such until very recently. So much for some of the historical background of Callao.

Peru covers an expanse equivalent to the combined areas of France, Germany, and Italy. Callao is her foremost port, and lies 1,500 miles south of Panama. Most of the other ports along this coast are little better than open roadsteads that make the transshipment of cargo contingent upon the condition of the weather. Even when strong or stormy winds are not blowing there is a prevailing long ground swell that becomes at times of troublesome proportions and hampers vessels at anchor offshore. Between Guayaquil, Ecuador, and Valparaiso, Chile—a span of 2,500 miles, Callao can boast a port possessing the best natural protection. Therefore it is not hard to understand why Callao so long enjoyed preëminence and drew to her ships from the Seven Seas.

While the winds coming in from the sea—generally from the south—seldom attain a velocity of more than 12.5 miles an hour, still the Pacific ground swell, likewise from the same direction, would seriously hamper the haven if it were not for the barriers formed by the islands of San Lorenzo and Fronton. These, combined with a shoal known as the Whaleback and the spit of land called La Punta, shelter the harbor from the west and southwest but leave it open to the ocean from the north and northwest. As a result, the strong swell in the open ocean sweeps around the northern end of San Lorenzo Island and enters the bay from the northwest, but fortunately with much reduced force. During storms outside, however, the swell is strong enough to make it impossible for vessels to lie at the old docks, which were built in 1877 by a French company operating under a concession. As time went on, the docks became inadequate for handling the increasing traffic of the port.

Large vessels drawing more than 20 feet of water could not make use of the docks, and such craft had to load and unload while lying at anchor. These ships were served by

lighters in doing this work—a procedure that added materially to freight costs. Extension of the docks required under the concession for the purpose of taking care of growing traffic was not commensurate nor typically modern; and the accommodations of the port were expanded in a haphazard and somewhat inefficient manner.

Cargo-handling facilities at the old Darsena docks.

Normally, the Port of Callao is called upon to handle 125,000 tons of exports and 400,000 tons of imports annually. These figures represent an average over a period of years and, if anything, are rather conservative. One way or another, Callao plays a prime part in the economic life of Peru; and with the realization of this the government began to seek the advice of experts of different nationalities back in 1912. Finding it next to impossible to reconcile the differing plans submitted, the government in 1926 asked the Frederick Snare Corporation, of New York, to make an independent survey and to offer a solution. The resulting report covered the engineering, economic, and financial aspects of the question. It also included definite plans and specifications and the estimated cost of the improvements recommended. Based on this report, a contract was entered into between the Government of Peru and the Frederick Snare Corporation. The cost of the entire development was estimated at approximately $6,500,000. The contract was signed on March 23, 1928; the undertaking was to be completed within four years; and actual work was started within a few days after the contract was executed.

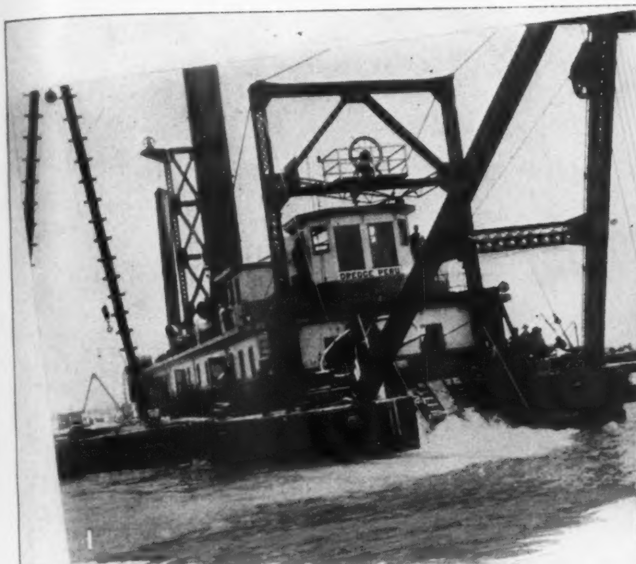
The accommodations for shipping and for handling freight prior to 1928 were not only inadequate but their arrangement was such that arriving freight requiring housing and customs inspection were forced to follow a route that virtually bottlenecked the movement, occasioning delay and adding considerably to the expense of handling. The aim in planning a new port was to construct it at a cost low enough to be paid for out of the operating savings to be made possible; and a further object was to stimulate trade by giving immediately to shippers a portion of the saving by reducing the charges previously paid by them. Now let us see how these ends have been rendered attainable.

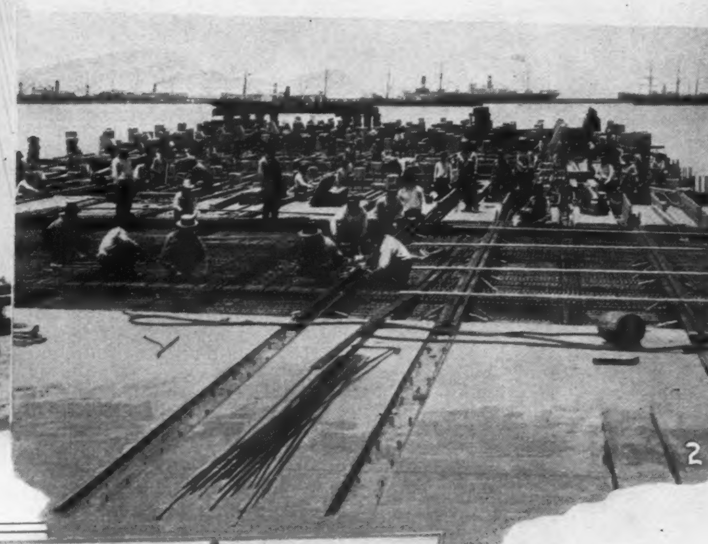
Borings disclosed that the harbor bottom consists of a heavy blanket of silt overlying a bed of hardpan of great thickness. While the hardpan reaches well-nigh to the surface at the shore line, still it dips so rapidly that 4,000 feet from the beach, where the water is about 30 feet deep, it lies 100 feet or more below the surface of the harbor. This 70-odd feet of silt is composed of thick layers of mud alternating with layers of hard-packed sand a foot or so in thickness. The problem was to ascertain by experiments how much of a load the silt would sustain before yielding and allowing the unit weight to settle through it to the hardpan. Nothing short of the hardpan could be counted upon for permanent support.

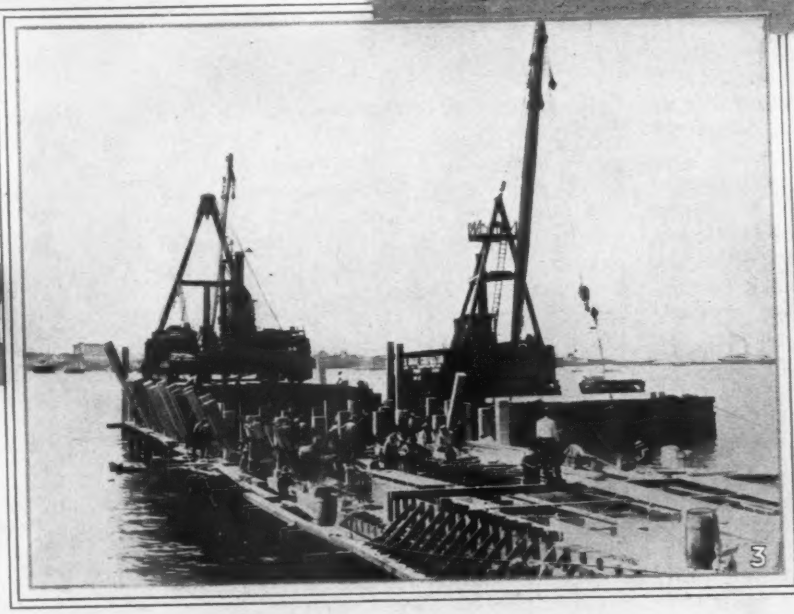
With these preliminaries concluded, then began the work of building the two breakwaters that now enclose an area of about 1⅛ square miles. The entrance between these breakwaters is 600 feet wide, and the position of this opening and the arrangement of the two breakwaters are such that the ground swell from the ocean is shut out from the enclosure. There is room enough within the new basin to provide docks to take care of the present traffic and to allow for an expansion in excess of three times the present capacity. About 60 ships engaged in foreign trade call at Callao each month, and something like 100 smaller boats engaged in local coastwise trade enter the port every 30 days. The plan called for eight full-size berths for shipping in foreign trade, while the more important craft in coastwise trade were to be handled at the bulkhead wharves between the piers. The old Darsena docks were counted upon to take care of the less important local and coastwise traffic in which light-draft sailing vessels are employed.

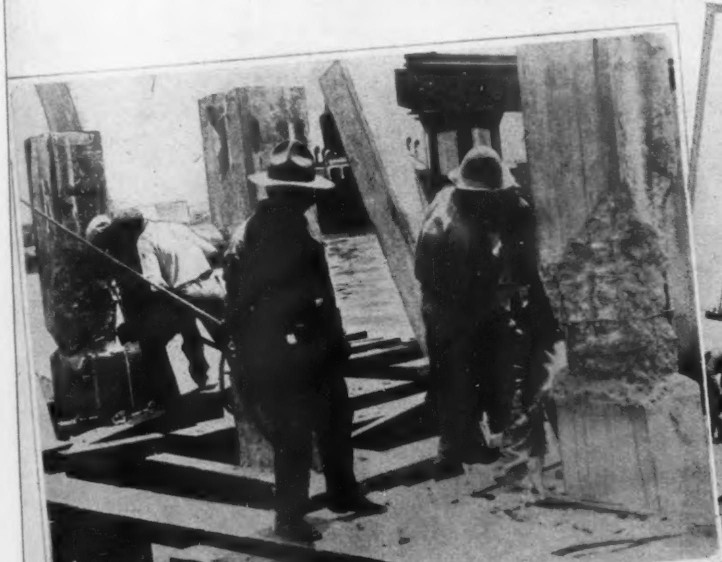
The eight new berths are provided by four up-to-date piers 600 feet long. Two of these are open piers, 100 feet wide, and are intended to handle bulk cargo. The two other piers are of the filled type, 282 feet wide, and on each are two warehouses 90 feet wide by 540 feet

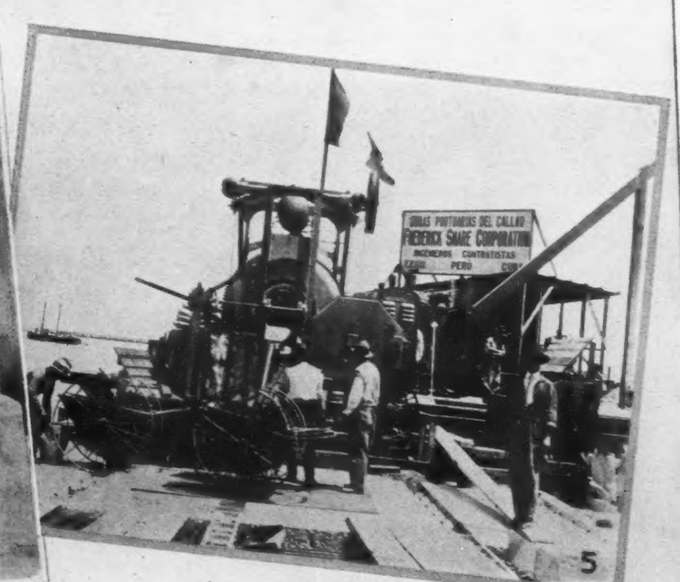
Airplane picture of four new piers while under construction.












1—Dredge "Peru" that made the voyage from the Port of New York to Callao. 2—Placing reinforcing rods in the deck of one of the new piers. 3—Facilities used in speeding up work on the new piers. 4—Cutting away concrete with "Jackhamers" so as to expose reinforcing steel to make a better bond with the concrete deck. 5—Central concrete-mixing plant that played an effective part in promoting rapid progress.

**Left—Tunnel in hillside before shooting. Right—Face of quarry after a blast.**

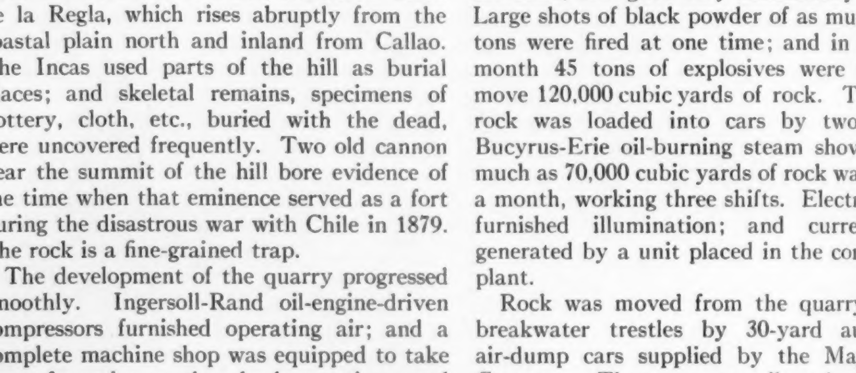
in length. Contrary to previous practice at the port, all customs inspection henceforth will take place on the piers themselves. Because the rainfall in Callao is nearly negligible, only a small amount of warehouse space is required. The draft of vessels entering Callao has hitherto ranged from 20 to 34 feet. With an eye to the future, the government decided that the entrance channel, the turning basin, and the slip between the wide center piers should have a depth of water of 37 feet. The scheme entailed a total of 2,600,000 cubic yards of dredging and an equal amount of fill—the fill creating 150,000 square yards of reclaimed land between the bulkhead and the shore. The land so made is to be utilized for storage, tracks, roadways, and other purposes.

After a single-track railway of standard gage was built to connect with the Central Railroad for construction work and extended to a quarry about three miles distant, operations were begun on the breakwaters. It was important that the breakwaters be advanced with all practicable dispatch so as to shut out the sea and to protect the area within which the piers were to be reared and the dredging done. The trestles for placing rock fill in the breakwaters went forward on a 3-shift basis and as fast as material could be delivered. The piles were driven to hardpan by special overhang railroad pile drivers equipped with McKiernan-Terry steam hammers. No difficulty was experienced in going through the sand layers; and the piles for much of the outshore sections were spliced up to 100 feet in length. The standard bent consisted of two vertical and two batter piles. Two additional piles per bent were added for the deeper portions of the breakwaters. The bents were spaced on 12-foot centers; and when the work was in full swing as much as 2,300 feet of trestle was completed in a single month. All told, a total of 10,000 feet of trestle was constructed.

Rock for the breakwaters was obtained from the west face of a hill, known as Cerro de la Regla, which rises abruptly from the coastal plain north and inland from Callao. The Incas used parts of the hill as burial places; and skeletal remains, specimens of pottery, cloth, etc., buried with the dead, were uncovered frequently. Two old cannon near the summit of the hill bore evidence of the time when that eminence served as a fort during the disastrous war with Chile in 1879. The rock is a fine-grained trap.

The development of the quarry progressed smoothly. Ingersoll-Rand oil-engine-driven compressors furnished operating air; and a complete machine shop was equipped to take care of repairs on shovels, locomotives, and other plant machinery. It was deemed wise to avoid delays by keeping on hand a full line of spare parts for all machines; and because of this precaution not a single serious delay occurred on account of breakdown. The tunnel method of blasting was employed from the start, and gave very satisfactory results. Large shots of black powder of as much as 20 tons were fired at one time; and in a single month 45 tons of explosives were used to move 120,000 cubic yards of rock. The loose rock was loaded into cars by two 3-yard Bucyrus-Erie oil-burning steam shovels. As much as 70,000 cubic yards of rock was loaded a month, working three shifts. Electric lights furnished illumination; and current was generated by a unit placed in the compressor plant.

Rock was moved from the quarry to the breakwater trestles by 30-yard automatic air-dump cars supplied by the Magor Car Company. Those cars contributed materially to the high rate of progress maintained. Their dumping can be controlled from the locomotive cab; and each car can dump on either side. In dumping, the body of the car is raised by pneumatic cylinders—thus al-



**Cerro de la Regla, the hill that has furnished all the rock used in building the new port terminal.**

Left—Loading copper ingots from Peruvian mines. Right—Handling cargo at one of the old docks.

most eliminating the impact and side thrust common to center-pivoted dump cars. At the same time the side of the car on the low side drops to form an apron continuous with the floor of the car, and this causes all material to clear the track and the trestle. The quantity of rock actually placed in both breakwaters reached a total of 1,350,000 cubic yards.

The manner in which the rock settled in the soft bottom was decidedly erratic. It would build up on a sand layer until the weight of the rock was great enough to break through and to sink farther. When this happened on both sides of a trestle at a given point it caused but little trouble; but more frequently the settlement was uneven, and then a side thrust was induced against the trestle, itself, tending to throw it out of alignment and to break some of the piles. Occasionally this virtually destroyed short sections of the trestle. This had been foreseen, and merely called for frequent repairs and continual vigilance to avoid serious accidents. A pile-driving rig was kept near the outshore end of each trestle to make prompt repairs so as not to interrupt the dumping of rock. Ordinarily, dumping was confined as far as feasible to the outer portions of the trestles; and even when a bad settlement occurred dumping could be continued along the inshore section until the particular damage was repaired.

In doing the foregoing repair work, new wooden piles, often more than 100 feet long, were driven through the rock embankment without serious difficulty with one or the other of the 9B-2 steam hammers. This was somewhat surprising in view of the fact that the fill contained rocks of many different sizes—some of them weighing as much as 5 tons apiece. After settlement ceased in the breakwaters, large rocks up to 15 and 20 tons each were placed on the embankments as a top dressing.

The piers and the bulkheads were built of reinforced concrete supported by precast-concrete piles 18x18 inches and 20x20 inches in cross section. A central concreting plant turned out the piles; and as many as 455 were cast in a month. By means of special traveling derricks the piles were driven successively from the tops of the piles previously driven; and this procedure saved much time. In penetrating the hardpan of cemented gravel the piles were jetted with water at a pressure of 200 pounds and driven by steam hammers the while. Twenty-eight bents of the bulkhead wharf, made up of 168 piles, were driven in a month by one rig.

The dredging of 2,600,000 cubic yards of material was done by a dredge towed 3,500 miles from the plant of the Federal Shipbuilding Company at Kearny, N. J. The craft was designed and operated by the Gahagan Construction Company, of New York, and was given watertight bulkheads, a generous freeboard, and a molded bow—all to assure seaworthiness. The *Peru*, as she was christened, is equipped with the most modern machinery; and she was towed the long trip without any difficulty and in record time. This novel dredge is now on her way back to the United States after doing efficiently the work expected of her.

The four piers finished are being equipped to meet present traffic requirements, and further facilities will be provided as the demand grows. Ultimately, it is planned to give the port a total of twelve modern piers. Despite disturbed political conditions in Peru, none of the contending parties has shown any disposition to halt work on the port development.

The contractor has given striking evidence of how an experienced and capable organization can carry through a great and difficult undertaking when operating thousands of miles away from his established source of supplies.

General view of harbor including the old and the new docks.

## SAND-BLASTING WITH DIFFERENT KINDS OF ABRASIVES

THE following results of comparative sand-blasting tests with silica sand, alundum, and steel grit should be of wide interest because they were made under service conditions and are, therefore, more or less conclusive. The work was done under the direction of one of the engineering departments of the American Hardware Corporation; and 200 pounds of each material was used over and over again until it had lost its effectiveness.

The records show that 4,700 pieces were blasted with the sand; 20,000 with the alundum; and that the steel grit did not break down until it had cleaned in excess of 80,000 pieces. The life of the latter abrasive was therefore more than seventeen times longer than that of the sand and about four times longer than that of the alundum. Other advantages, as revealed by the tests, were:

There was little if any dust to be found in the cabinets. The screen separator on the exhaust system had to be cleaned but once in three months instead of twice a week, as is the case with sand. The handling of but 16 tons of steel grit a year as compared with 330 tons of silica sand means an appreciable saving in labor, as well as in such equipment as sieves, shovels, and the like. Where three iron nozzles were worn out daily by the sand one nozzle stood up to from three to four weeks of service with the grit. The parts blasted with steel grit did not have to be dipped in acid in the plating department to give them a good finish, while their cleaner surface also served to facilitate japanning or lacquering operations.

Offsetting these good showings is the one item of cost. Sand comes to but $6 a ton, including freight, and steel grit costs $100 a ton.

## FROZEN ORANGE JUICE FOR HOME CONSUMPTION

FROZEN orange juice brought to your door much as milk is delivered is just another of the many achievements of the refrigerating engineer. In the citrus-fruit belts of Florida and California are in commercial operation special plants where the juice of the golden fruit is extracted and frozen for immediate distribution or for storage.

Different processes are in use; but it would seem that the secret of a successful product lies in excluding all possible air from the juice from the moment extraction is begun until it is packed in air- and liquid-tight containers either before or after hard freezing. Juice obtained, precooled, and frozen with a minimum of exposure to air will, it is said, retain its flavor for a long time and can, under certain conditions, be kept indefinitely in storage at zero Fahrenheit.

By the newest method developed, the juice is first turned into flakes in cylindrical or drum freezers. The flakes are then compressed into bricks and subjected to another freezing in a different type of freezer before the bricks are placed in air- and water-tight containers for delivery to the consumer.


NATURAL GAS, by J. C. Youngberg. A volume of 204 pages, published by Schwabacher-Frey Company, San Francisco, Calif. Price, $2.50.

NATURAL gas, according to the author, is America's fastest-growing industry, and the foreword of the present volume tells the reader that the object is to give investors a general and comprehensive knowledge of the natural-gas industry, of its tremendous future, and of the attendant possibilities for profit through wise investment. To quote: "The inevitable expansion on a nation-wide scale of the natural-gas industry which is now being intensively sponsored by America's leading financial, utility, and industrial interests is progressing so rapidly that what is current information today is quite possibly ancient history tomorrow."

This book contains considerable general information on the subject of natural gas as well as a good deal of data about the large companies now engaged in exploiting this natural resource.

CHEMICAL ENGINEERING CATALOG, Fifteenth Annual Edition. An illustrated volume of 1168 pages, published by The Chemical Catalog Company, Inc., New York City. The price is either $3 or $10—the lesser charge being made to chemical engineers and others engaged in different lines of chemical work.

DESCRIBED in general terms, The Chemical Engineering Catalog is the official, standard work of reference for chemical engineers, works managers, purchasing agents, operating engineers, and others who buy and specify equipment and materials in the industries using chemical processes. Expressed in another way, it is a compilation of condensed catalogue data—standardized as to page size and typographical arrangement—supplemented by classified indexes of equipment, supplies, chemicals, and materials, and made up into a single volume for convenient reference. It is, in short, a roomful of individual catalogues, abstracted, indexed, and assembled within the covers of a single book.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, INC., 1930 YEAR BOOK. An illustrated volume of 485 pages, published by The Institute, New York City. Price, $5.00.

THE papers published in the present volume have to do with metal mining and with nonferrous metallurgy. Under metal mining, the papers are: Miami Copper Company Method of Mining Low-Grade Orebody; Vertical and Incline Shaft Sinking at North Star Mine; Some Recent Developments in Open-pit Mining on the Mesabi Range; Protective Measures Against Gas Hazards at United Verde Mine, etc., etc. Among the papers having to do with nonferrous metallurgy are: The Leaching Process at Chuquicamata, Chile; A Petrographic Study of Lead and Copper Furnace Slags; Improvements in the Metallurgy of Quicksilver; Progress in Production and Use of Tantalum, etc., etc.

STANDARDS YEARBOOK, 1931. A volume of 399 pages, compiled by The National Bureau of Standards, and purchasable from the Superintendent of Documents, Washington, D. C. Price, $1.00.

THE present volume is the fifth issue of the yearbook, and, like the preceding issues, is a veritable treasure house of information along numerous lines. The subjects covered are standardization in transport; international standardizing agencies; national standardizing agencies; federal standardizing agencies; and the multiple activities of The National Bureau of Standards. This book will be worth many times more than its price to a very wide circle or readers.

A JOURNAL OF MY JOURNEY TO PARIS IN THE YEAR 1765, by Rev. William Cole. A volume of 410 pages, with a picture plan of Paris, published by Richard R. Smith, Inc., New York City. Price, $5.00.

QUITE apart from their quaintness and their contemporary tone, records like those made by the Reverend Cole shortly after the middle of the eighteenth century are not only historically worth while but they serve as a gage in measuring the social changes that have come about in the meantime. In addition to carrying us back nearly 170 years and giving us crisp and vital pictures of the period, the diary reveals a side of Horace Walpole but little known; and the lifelong friendship existing between Cole and Walpole emphasizes again how very strong bonds can bind two radically dissimilar and apparently antagonistic personalities. Cole's diary is an interesting and even fascinating volume in many particulars.

HANDBOOK FOR PROSPECTORS, by M. W. von Bernewitz. An illustrated work of 359 pages, published by McGraw-Hill Book Company, Inc., New York City. Price, $3.00.

THIS book as now offered is the second edition of a volume first issued in 1926; and, apart from some errors corrected, it contains recent information on certain minerals and an entirely new chapter on geophysical prospecting. Inasmuch as prospecting is undeniably the basis of the mining industry, the potential usefulness and value of this handbook should be clear to anyone engaged or about to engage in this field of endeavor. The author has striven to provide information in all directions essential to the prospector.

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